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## Contents.

| | PAGE |
|---|---|
| Forthcoming Events | 421 |
| International Standards | 421 |
| Cast Iron Resists Corrosion | 421 |
| Correspondence | 422 |
| The "Cosibelge" | 422 |
| Catalogues Received | 422 |
| Random Shots | 422 |
| Anodic Treatment and Dyeing of Aluminium Castings | 423 |
| Iron and Steel Production | 424 |
| Prevention of Porosity in Castings | 425 |
| Some Experiences with Routine Sand Testing of Green Sand | 426 |
| Better Lead Outlook | 427 |
| The Heat-Treatment and Testing of Chains | 428 |
| Pig-Iron and Steel Output | 429 |
| A New Canadian Steel Foundry | 430 |
| Nitrogen in Iron-Carbon Alloys | 431 |
| Steel Import Duties | 431 |
| This Week's News in Brief | 432 |
| Company Reports | 432 |
| Contracts Open | 432 |
| Obituary | 432 |
| Raw Material Markets | 434 |
| Import Duties Advisory Committee | 434 |

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN, THE NATIONAL IRONFOUNDING EMPLOYERS' FEDERATION, THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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## Forthcoming Events.

**Institute of British Foundrymen.**
JUNE 20-23.
*Institute of British Foundrymen*:—Annual conference in Cardiff.

## International Standards.

We would like to sound a note of caution with respect to the question of international tests. This question is being very actively discussed in various directions and particularly in connection with moulding sands. Experience has shown that few things are more difficult than the establishment of a generally accepted method of testing for international use. If agreement in such matters were readily obtainable we should long ago have enjoyed a universally accepted international language and system of weights and measures. Nobody is particularly interested in achieving international standards and there is no international body working to this end. As we are aware great difficulties were found under the old International Association for Testing Materials because certain Continental countries desired to use it as a machine for international standardisation. Efforts to promote an international standardising body are looked upon with suspicion in this country because there is an inevitable tendency for some countries to look at the problem not from a strictly scientific or technical point of view, but from a point of view dictated by the commercial interests at stake. The successor to the old International Association for Testing Materials has, for this and other reasons, deliberately excluded international standardisation and specification from its scope, and this policy is being rigidly enforced. Only on these conditions can it count on the unreserved support of all the countries concerned.

The question of arriving at some method which permits results obtained in one country to be compared with those of another is an entirely different matter, and this is, of course, highly desirable, although too much importance may easily be attached to it in view of the differences between countries in their natural resources and practices. Agreement between any two countries, moreover, does not imply that the path towards international standardisation is rendered any easier. Countries which to-day have made practically no contribution to the study of particular tests will claim the right to a voice in a particular standard. For about twenty-five years such a comparatively simple matter as the international standardisation of a notched bar for the impact test has been under discussion, without finality.

We think that the interests of ultimate standardisation internationally are best served by each country working out the methods which suit it best, and then arriving at a standard later on in the light of the whole of the information gathered from the formulation of such tests, and we trust that any such proposals will not carry the argument that they are in the interests of standardisation on an international basis.

## Cast Iron Resists Corrosion.

There is much of interest to the grey-iron founder in the 13th (Interim) Report of the Committee of the Institution of Civil Engineers on the Deterioration of Structures in Sea Water. *Inter alia*, the Report deals with two series of 10-year exposures of various metals and alloys to aerial and sea water at Auckland, New Zealand, and Halifax, Nova Scotia, and in general cast iron proved itself to be inferior only to 36 per cent. nickel steel and 13 per cent. chromium steel. Another generalisation is that cold-blast iron resisted better than hot-blast material. Dr. J. Newton Friend has been scrupulously fair to the range of materials used by him, but since the inception of these experiments about 11 years ago, cast iron has made such considerable progress that it would seem desirable that the experiments should be repeated, using some newer grades of alloyed cast iron. They have recently behaved quite satisfactorily in accelerated tests carried out in both acids and alkalis, and under salt-water spray tests. The results achieved will merit their inclusion in such prolonged tests as the Committee has been carrying out. As a result of this work, comparative figures are available of between five and ten years' exposure and further tests need no such prolonged period as ten years, it having been established that as corrosion proceeds the difference in behaviour as between the various metals becomes less pronounced. The fault with cast iron is that, while there is a comparatively small loss of weight, the corrosion does penetrate inwards. We suggest that a little preliminary investigation on this matter would enable the foundry industry to supply a material free from this defect. After all, if the steelmakers submitted such materials as those containing 35 per cent. of nickel; 13 per cent. of chromium; 2 per cent. of copper, surely the foundrymen have a duty in submitting nickeliferous, chromiferous and austenitic cast irons? We would hazard a guess that some of the results shown would equal those obtained from the high-nickel steel, and, moreover, be commercially of greater import owing to the decreased cost of manufacture.

## Correspondence.

*[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]*

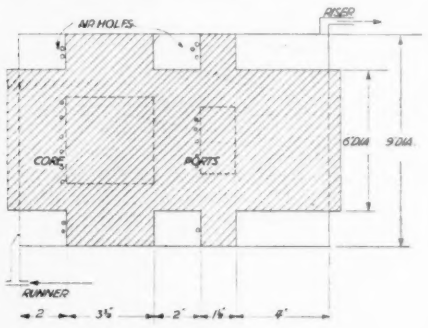
### Soda Ash Blow-Holes.

*To the Editor of* The Foundry Trade Journal.

Sir,—With regard to the article entitled "A Phase of Recent Research in Foundry Technique—The Use of Soda Ash," by N. L. Evans, B.Sc., A.I.C., which appeared in your issue of December 1 last, the measures recommended were tried out in our foundry when casting locomotive-cylinder sleeves, valve liners, rings and covers, for which a closer-grained metal is desirable. An 800-kilo ladle was employed, and a parcel of 8 kilos, *i.e.*, 1 per cent. of soda ash in the granular-powder form was put in the bottom of the ladle before tapping; plenty of time was given for the reaction to take place, and ground limestone was held in readiness to thicken the slag.

It was found practically impossible, however, to skim off the whole of the slag from the top of the metal.

The mixture used was:—25 per cent. pig-iron—Gartsherrie No. 1; 25 per cent. C.I. wheel




centres; and 50 per cent. foundry scrap, old axleboxes, etc. Lime is always used for slagging out.

Undoubtedly a closer-grained metal was obtained, but in the case of the valve liners what appeared to be air-holes were formed under all the ports, and as these were not due to dirt, we consider they were caused by the metal working in the mould.

I enclose herewith a sketch of the sleeves in question, and should be very much obliged if you would be kind enough to let me know if you have heard of any similar occurrences and if there is any remedy to prevent such occurrences.—Yours, etc.,

S. A. R. Phelps,
Works Manager.

Ferro Carriles de Entre Rios,
Paraná, Argentina.
May 9, 1933.

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**Mechanical Properties of Large Forgings.**—In "Stahl und Eisen," E. Maurer and H. Korschan describe in a long illustrated report the results of experimental work on the mechanical properties of large forgings. Four 100-ton castings were made of soft non-alloy steel, a low-alloy Mn-steel, a Ni-steel and a Cr-Ni-Mo-steel, and forged in a 15,000-ton press. Forgings 1,450, 1,180 and 920 mm. in dia. were made from each casting, and each reheated and killed in the usual way. Continuous temperature measurements were made at various points of each piece during heat treatment, and the effect of the diameter and the cooling medium on the temperature distribution studied. Discs were cut from each piece at different stages and tested by standard methods, as well as careful chemical analyses made. The mechanical tests applied covered a wide range, samples being taken from the centre of each piece by drilling. The results are represented graphically, and show the effects of alloying, heat-treatment and forging on the structure and mechanical properties of the four materials.

## The "Cosibelge."

### NEW BELGIAN STEEL COMPTOIR.

The Belgian steel comptoir, which was formed on May 30 for the disposal of products included in the marketing syndicates recently established on the Continent, has now been registered under the title of the Comptoir de Vente de la Sidérurgie Belge (Cosibelge), with offices in the Rue de la Chancellerie, Brussels. The comptoir is a co-operative company with a share capital of 5,000,000 fcs., divided into 5,000 shares of 1,000 fcs. Eight large steel concerns have each subscribed 625 shares. It is stated that the extensive Usines Metallurgiques du Hainaut, of Coullet, is not among the founders of the Cosibelge.

The Cosibelge comprises provisionally four groups, one each for semis, bars, joists and sheets, each under a committee of three members. The chairman of each committee is the representative of the principal producer in each group; thus Cockerills provide the head of the semis group, Clabecq of the sheet group, Ougrée of the joists group and Providence of the bars group. The functions of the Cosibelge are designed to be on the lines of those of the German "Stahlwerksverband," although initially not with the same extensive powers. All sales are to be conducted through the Cosibelge.

About 25 Belgian exporters have already registered with the Cosibelge and agreed to transact business under the terms stipulated in order to derive the same advantages as the works' merchants. Other exporters and merchants are complaining of the conditions and the risks attached thereto. A complete *rapprochement* between the Cosibelge and the exporters is thus still doubtful.

## Catalogues Received.

**Case-Hardening Materials.** — G.W.B. Electric Furnaces, Limited, of Elecfurn Works, North Road, Holloway, London, N.7, have sent us advance copies of two leaflets dealing with Kleenard—an open-hearth hardening compound—and Nokase—an anti-carburising mixture. With Eternite, which is well known and much appreciated, a case-hardening compound for use when conducting operations in closed boxes, there is now available a complete range of materials for use in this particular section of the engineering industry. The leaflets describe the advantages of the materials and state the prices charged.

**Oven Thermostats.** — The General Electric Company, Limited, of Magnet House, Kingsway, London, W.C.2, have sent us a leaflet which describes and illustrates a thermostat for controlling the function of ovens, stoves and furnaces operating at temperatures up to 600 deg. C.

In general principle the operation depends on two materials expanding at different rates. Special attention has been given to the correct selection of these materials to maintain consistency of calibration and to avoid the troublesome effect of "creep." The active portion of the thermostat consists of an outer tube and an inner non-expanding rod. The difference of expansion of the two materials actuates levers, which operate the switching mechanism.

The electrical portion of the thermostat is suitable for dealing directly with loads of 15 amps. up to 250 volts a.c. and 10 amps. up to 250 volts d.c. For higher loadings the thermostat should be used in conjunction with contactors; on d.c. circuits a small condenser must be connected in parallel with the contactor-operating coil. The switch mechanism is of the quick-make-and-break action, and fitted with a magnetic blowout. The standard length of the outer metal tubes is 24 in., but longer tubes can be supplied. For longer tubes supports must be provided.

## Random Shots.

"Phew! Isn't it hot?" From Kynance Cove to Lindisfarne, from Herne Bay to Rothesay, from Southampton to Skegness, from Westcliff to Whitley Bay, etc., etc., the same words are on every lip. There can be no doubt about it. It *is* hot (at the time of writing).

* * *

I have sometimes wondered why it is that in such weather everyone (including myself) makes *en bloc* for the seaside, because, you know, there is less shade beside the sea than almost anywhere else, and from what I now hear around me on the Marine Promenade, when the temperature starts this Mount Everest stuff, shade is more precious than the jewels of Ophir. Moreover, the seashore is a desert in minature (and who yearns for the Sahara in this weather?), while the limp and wretched parents whom I can see calling their children home across the sands of Dee, look, as they struggle through the sand, for all the world like very, very hot and perspiring pilgrims reaching the end of the golden road to Samarkand. The sea itself, although pleasant enough to bathe in, is largely composed of salt, and what could make one feel more thirsty than salt? Yet I and all those perspiring *patresfamiliarum* have to sit and watch that beastly sea till they open at 6 o'clock.

* * *

In the tropics, where they know how to deal with this sort of weather, I would not be sweltering in this uncomfortable deck chair upon a burning concrete cliff, exposed to the chatter of silly women and loathsome children. Instead, I should be at home, in bed, and somewhere in the dim shadows would be an electric fan. . . .

* * *

It seems to me, drowsing in this extremely collapsible deck chair, that the foundryman should not attempt to spend a holiday at the seaside. The absolute essential of a holiday is change, and, really, I may be fanciful, but life at the seaside is very like life in a foundry. Below, on the beach, I can see a man *moulding* sand castles, and beside him a *patternmaker* tracing out designs in the sand. Near by a youthful *sand mixer* is carrying out a rough *physical analysis of sand*, as he thoughtfully pours a spadeful over the recumbent form of his uncle. *Heat reactions* are noticeable everywhere. People are *baking* in the sun, and *sagging* as they walk. They are *quenching* their thirst with *soda* (ash). In the sea, where I trust no rowing-boats are *founding*, bathers, *stripped* and *hardened in a brine solution*, look like having a *scrap* with small boys who have been *casting* stones at them. The small boys will soon be *runners*. On the promenade I can see a convivial holidaymaker, who, as yet untroubled by *tin uncertainties*, has been rioting on bottled beer, and is now *fabricating* an excuse to tell to his wife. She is on the beach chasing her *refractory* children. In the distance I can hear a *brass* band and the funny man of the nearby concert party is a *gagger*.

* * *

Altogether, the whole place is just exactly like home. You cannot get away from the foundry.

* * *

An Englishman was appointed manager of an Aberdeen business which had been declining. So successful were the methods of the newcomer that, at the end of the year the profits showed an increase of 200 per cent.

The manager was sent for, and the gratified chairman of directors addressed him as follows: "Well, Mr. Jones, we have decided to make you a present of this cheque for £100, and, furthermore, I am authorised to say that, if at the end of our next trading year we maintain our present level of profits, we shall have much pleasure in dating and signing it."

Marksman.

# Anodic Treatment and Dyeing of Aluminium Castings.*

By N. D. Pullen, A.I.C.

The phrase "anodic treatment" as applied to aluminium and its alloys is, as far as this country is concerned, almost synonymous with the process invented by Dr. Bengough and his co-workers, although, strictly speaking, it refers to any process in which the material to be treated is made an anode in a suitable electrolyte under an applied E.M.F. It might be interesting, therefore, to consider the various processes which are being used commercially for the protection of aluminium and some of its alloys.

These processes can be readily divided into three groups, not only as to the electrolyte used but also as to their country of origin, as follow:—

| | | |
|---|---|---|
| Chromic-acid group | ... | British |
| Sulphuric-acid group | ... | American |
| Oxalic-acid group | ... | German |

—and it should be noted that the films produced under these three headings are in many ways distinctive.

The chromic-acid films are more or less opaque and when produced on pure metal are of a pearly-grey colour. When freshly formed they are definitely soft, but the resistance to abrasion shows a marked increase with age. Sulphuric-acid films, on the other hand, are transparent and practically colourless, and in the freshly-formed condition rather harder than those produced in chromic acid. The films produced in oxalic acid are of a third type distinct from the others. They are more or less transparent, but have a distinct yellow tinge which varies in intensity, depending upon the particular manner in which the film has been produced. In the same way the hardness varies from extremely hard brittle films to soft and comparatively flexible ones.

For the treatment of castings it rarely happens that more than two types of film are required, that is to say, resistance to corrosion combined with good dyeing properties and/or resistance to abrasion. Flexibility need not be considered, as, unlike a piece of sheet or wire, the material is not required to withstand deformation.

The two types of castings with which it is proposed to deal are (*a*) those where maximum resistance to atmospheric and/or marine corrosion is required, the appearance being of secondary importance, and (*b*) castings made and designed primarily for decorative work. There is a third type, which includes material to be used for special purposes where the films have to withstand a definite set of conditions such as moving parts of water or gas valves, pistons, electrical apparatus requiring a high insulation, etc., but these hardly fall within the normal run, as each has to be treated by special methods designed to give the results required.

### Preparation of Castings for Anodic Treatment.

*Non-Decorative.*—Under this heading are included all material on which an oxide film is to be formed, with the sole object of increasing resistance to corrosion, so that, providing the particular alloy chosen for the job is capable of producing a good-quality film, the actual colour of that film is of little importance. In preparing the castings for treatment a few important rules must be observed, and these apply to all cases, whatever the ultimate object. They are as follow:—(1) All machining, drilling, polishing, etc., must be completed before the treatment; (2) the casting must be free from foreign-metal insets, particularly brass or copper; and (3) the surfaces, particularly of sand castings, must be treated in such a way as to remove all traces of foreign matter which might be adhering to them.

It is assumed that all castings are of good quality, but, as is well known, it is no easy matter to produce material entirely free from surface cracks, pin-holes and the like on all occasions, and this leads to a certain amount of trouble. The "throwing power" of the solutions is of a very high order, the electrolyte penetrating cracks, etc., and causing a film to form there. This is very desirable, but, unfortunately, washing the solution out of such cracks after the job is finished is a very difficult matter.

This is one of the disadvantages of the Bengough process. The chromic-acid solution has a high-colouring value, and no matter how well the casting may be washed after treatment, there always seems to be enough acid left in some crevasse or other to seep out and form a deep-yellow stain. The result is often unsightly, but for the particular purpose now under consideration it is not dangerous, as the film at such points is not damaged.

The alternative is to use a colourless electrolyte, such as a sulphuric acid. There will be no staining in this case, but the author is not at all satisfied that it is an entirely safe procedure, since, under atmospheric conditions, a concentration of sulphuric acid would be produced which could re-dissolve the film. There is no risk of this happening in the case of the Bengough process, as the film is not soluble in the chromic-acid solution.

Where permissible, small cracks, etc., could be opened out by cutting away the edges, thus enabling them to be washed out more readily. Several methods have been tried for removing the chromic acid stains, but so far none seem to be entirely satisfactory, although a considerable improvement can be effected by immersion in a 0.05 per cent. solution of boric acid in distilled water heated to boiling point.

*Decorative.*—In this case, of course, appearance is of primary importance. In the preparation of the material the same rules apply as for the previous case, with the addition of others covering methods of casting, type of alloy to be used, etc. As is generally known, many alloys give films which, whilst they are quite good from a corrosion-resistance point of view, are self-coloured and so of little use for subsequent dyeing operations except where the colour to be applied is similar to the natural tint of the film. Generally speaking, the choice is limited to a few alloys which give a white or nearly colourless film.

Apart from the choice of alloy the results depend to a certain extent on the method of casting, especially in the case of alloys which respond to heat-treatment. No general rule can be laid down; in some instances chill castings give cleaner films than sand, and in others the reverse is true. In the case of sand castings the use of chills is apt to complicate matters, and discrimination must therefore be exercised. If one part of the casting is chilled at a greater rate than that of the rest, the film over that part will be liable to be of a different tint, and in the case of an alloy which is heat-treatable, the subsequent heat-treatment may not entirely remove the difference in tint.

Welding also causes trouble, and if unsightly patches are to be avoided it is essential that the welding rod shall be of the same composition as the material to be welded, as well as keeping the areas of the front of the weld as low as possible. It is sometimes necessary to carry out welding operations on material already heat-treated. In such cases the affected areas must be re-heat-treated, otherwise a patchy film will be produced at these points which is very conspicuous. It will be seen therefore that in order to obtain an even film over any surface it is necessary that the composition of the metal and its constitution be uniform over that surface.

### Foundry Influences.

Before discussing the various processes of anodic treatment and dyeing, it seems pertinent to draw particular attention to the points which are under the direct control of the foundry and upon which so much depends. In the first place the alloy must be up to standard and more particularly to chemical composition, since this controls to a very large extent the final colour of the film whether dyed or not. The dyer can control the colour depth on any one batch of articles, but it is not a practical proposition to try to control individuals. If he is supplied with, say, 100 articles made from ostensibly the same alloy but in several heats of varying composition, each heat will dye to a slightly different shade.

Secondly, the anodic treatment, especially Bengough's process, accentuates defects and no operator can produce good results from a poor casting. If the result is a failure due to cracks, pinholes, etc., the castings, being themselves at fault, must be scrapped and replaced by good ones.

Thirdly, if a highly-polished finish is desired it must be applied to the metal before treatment, since any of the processes permit of little or no control in this direction, and the same applies to matt surfaces. Deeply sand-blasted surfaces should be avoided where possible, owing to the heavy currents which they consume. In connection with polished surfaces it might be as well to point out that although fine cracks and pinholes can be made to disappear by polishing due to a certain amount of flow in the metal, they reappear in the film. If a perfect film be required a perfect metal surface must be supplied.

### Anodic Processes.

For preliminary information regarding the actual processes in use, one is limited in most cases to that given by patent specification, and whilst such information has to be sufficient to enable one to obtain the results described, it does not necessarily follow that they will be of the best quality. It is very difficult, therefore, to form any definite opinion as to the relative merits of the different processes.

The author can speak with a certain amount of confidence regarding the value of the Bengough process, as not only has this been in use commercially for several years, but also he has done a fair amount of experimental work on it himself. The other methods are comparatively new, at least as far as this country is concerned, and a verdict given for or against would be somewhat premature. What is proposed is to indicate the type of finishes which can be obtained by different methods and their field of application, and for this an attempt will be made to answer a list of questions which has been prepared by a practical foundryman.

### What Alloys are Most Suitable?

The answer to this depends to some extent on the particular process to be followed. Silicon alloys (5 to 13 per cent.) give good films but are self-coloured brown-black in all cases.

*Copper Alloys.*—For chromic acid process the copper content should not exceed 5 per cent., and the same applies to sulphuric acid. With oxalic acid, however, the copper may be higher (up to 12 per cent.). The films when formed are semi-transparent and practically colourless.

*Copper-Zinc.*—2L5 should give satisfactory results by either of the three processes; the films are colourless and can be dyed.



* Paper read before the Annual Conference of the Institute of British Foundrymen now being held at Cardiff.

*Zinc Alloys.*—Below 8 per cent., zinc alloys may be treated by either process, but above 8 per cent. they are not suitable for either chromic acid or sulphuric; they can, however, be treated in oxalic acid. Where formed the films are colourless in the former cases, brown in the latter.

*Heat-treated Alloys.*—"Y" is destroyed by chromic acid but gives very good colourless films in oxalic acid. For others containing copper it can be taken as a general rule that if the amount is over 5 per cent. the results will in all probability be unsatisfactory. It is desirable that wherever possible the copper shall be in solid solution.

**What Types of Finish can be Obtained and are they Permanent?**

This question covers a very large field which is continually growing, but it can be answered briefly as follows:—

(*a*) *Natural Films.*—In this group are included those films which do not require any after-treatment, *i.e.*, colouring, the effect being controlled by the composition of the alloy, the type of surface, whether polished, etched, etc., and the method used. They can vary from a slate-coloured film produced on a sand-blasted silicon alloy to an iridescent or golden film on polished 2L5.

(*b*) *Artificially-coloured Films.*—These effects are produced, of course, by the addition of colouring matter to an otherwise colourless film. In most cases the colouring matter is an organic dye, in others inorganic salts are used. As regards the use of organic dyestuffs, it seems advisable to issue a few words of warning. In the first case almost all films, especially when freshly formed, will absorb almost any dye with which they come in contact, and it is this fact which, in the author's opinion, is likely to lead to trouble.

The dyeing of aluminium oxide films is a new development, and one can hardly expect dyestuffs which are designed primarily for use in the textile industry to work equally well under an entirely different set of conditions. Dyes can be selected which are mordanted by aluminium on cotton, etc., and they may or may not work when applied to the oxide film produced electrically. Again, because a dye gives good results on one type of film, it does not follow that it will do so on another type. For instance, a particular red dye, if applied to a chromic-acid film, gives a brilliant colour which unfortunately can be boiled out readily. On the other hand, if applied to an oxalic-acid film, the colour resists all attempts to remove it.

As regards the second part of the question, that is, permanence, it can be said that the natural films should show very little change over several years. Chromic-acid films tend to become whiter; they all age-harden and lose the power to absorb dyes. With coloured films the result is liable to be rather different. It is claimed that, where inorganic salts are used as the colouring agents, the results are permanent, but as the author has not had an opportunity of examining such material at length, he is unable to pass an opinion.

Where organic dyestuffs are used, the permanence will depend to a very large extent upon the particular dye. It cannot be too strongly emphasised that, whilst some dyes give very good results, both as regards permanence to light and moisture, others are not as good, and it is much safer to limit oneself to a small range of colours which are known to give good results rather than offer a wide range, many of which will in all probability prove to be unsatisfactory.

By unsatisfactory is meant a liability to fade, say, within 18 months. Where the article being treated is not expected to have a life longer than this, then, of course, the choice of dyestuffs is widened considerably, but where a much longer life is desired, the choice of dyes is definitely limited, and until the special dyes, which have been referred to previously, have been produced, a wide range of colours will probably not be available.

**What Degree of Protection do the Films Afford Against Corrosion and Abrasion?**

The answer to this again depends upon the type of film produced, and it does not always follow that, because the corrosion resistance is good, the film is also hard. The Bengough films were produced primarily as a protection against the action of sea water, and there is no doubt whatever that they give very good results indeed in this direction. Their resistance to atmospheric corrosion is also very good, but they offer very little resistance to the action of alkaline liquids. Similar remarks also apply to other types of films, such as those produced by sulphuric and oxalic acids.

It must be pointed out, however, that this corrosion resistance is, in many cases, considerably increased by what is known as "after treatment" of the film. This consists in loading it with oils, waxes, greases, etc., which are selected for the particular purpose in hand. In fact, it rarely happens that the plain untreated film is used. Oxide films will not stand up to alkaline mediums, but the inventors of the Eloxal process claim that they are able to produce a treated film which will withstand the action of boiling 5 per cent. caustic soda for some time, and it appears that this claim can be justified.

As regards the resistance to abrasion, films can be produced which are extremely hard, but they are generally also rather brittle. In the case of castings, this does not matter very much, since no subsequent deformation takes place. Chromic-acid films, freshly formed, are certainly soft, but they show age hardening to a rather remarkable extent. After, say, the first month, the films are appreciably harder, and certainly at the end of two years become quite hard. It would be an advantage if this age hardening could be produced artificially, but so far this does not seem to be possible.

Sulphuric-acid, and especially oxalic-acid, films can be produced directly with the requisite hardness, and in addition they also appear to possess the required resistance to corrosive action.

The author has also been asked if he could say which process is the most satisfactory in the case of castings from the point of view of protection, but it must be understood that it is very difficult to answer this question. As mentioned previously, several of the processes are quite new, and there has not yet been any opportunity of testing them to any length.

**What is the Cost per Unit of Surface Treated and is there any Limit to the Size of the Specimens?**

In a Paper published some time ago on the working of the Bengough process, it was stated that the cost of treating material should be of the order of 1d. per sq. ft. of surface immersed, including labour, but apparently not including overhead charges or profit. Taking this as a basis, however, the sulphuric-acid processes are, on the whole, cheaper, and the oxalic acid dearer, but it is difficult to say just how great the difference is.

As regards the size of the specimens which can be treated, theoretically there should be no limit, but practically there is a limit. In assessing this, the current density in amps. per sq. ft. consumed by the alloy must be taken into consideration, and in doing this it should be noted that, whilst the consumption per sq. ft. might not be very high when averaged over the whole of the run, it frequently happens that the initial consumption is much higher. This is overcome to a great extent in Bengough's process by gradually raising the voltage to the maximum over the first 15 min. In some of the other processes, however, the current is turned on at the full voltage, and there is frequently a very big surge, and, although it may be possible to treat, say, 100 sq. ft. in a bath under the average current density, actually this may be cut down to less than half.

**What is the Patent Situation?**

As far as the author is aware, all the available commercial processes are covered by patents, so that licences to work have to be taken out. This is certainly the case with the Bengough process and with Sheppard's sulphuric-acid process. He is also given to understand that the German Eloxal process is covered in this country as well as the American Alumilite. The patents cover the use of a particular electrolyte, and there are also several specifications covering various methods of treating the film with waxes, oils, etc. Bengough also has a patent covering the process of dyeing an oxide film with aniline dyes, and this patent covers any process of dyeing any film, so that whichever method is used for producing the oxide film, it appears that a licence under the Bengough specifications has to be taken out if the film is coloured.

In conclusion, the author is most definitely of the opinion that there is a future for the anodic protection of aluminium and its alloys. There is no doubt whatever but that these methods do give a very high degree of protection against certain types of corrosive action. It is also true that at the moment they give very litle protection in certain circumstances, more particularly with alkaline liquids, but there are several indications that this will be overcome in the near future. Dyeing with aniline dyes needs to be considered rather carefully in order to obtain the best results. This is especially necessary in view of the rather large demand which there seems to be for coloured aluminium both cast and wrought for interior decoration, and although the organic dyes may drop out, there are great hopes of the inorganic colours which are now being developed.

In the early days aluminium was looked upon practically as an incorrodible metal, but it is now known that this is not strictly true. The protected material is, however, in an entirely different category, and there is every prospect that the adoption of one or other of the processes described in this Paper will lead to the greatly extended use of aluminium alloys in the not too distant future. It will be realised that as further experience is gained, and detailed improvements are introduced, the possibilities of protection and colouring will expand more and more.

Finally, the author wishes to thank the British Aluminium Company, Limited, for permission to give this Paper.

## Iron and Steel Production.

The National Federation of Iron and Steel Manufacturers, in their statistical bulletin for April, states that the tendency to an increased rate of production was continued in April, for although both in pig-iron and steel there was a reduction in the actual output for the month, the slight decline in the case of pig-iron was due to April having one day less than March, and the reduction in steel production was due to the Easter Holidays. Pig-iron output amounted to 324,700 tons compared with 332,200 tons in the previous month, and 316,900 tons in April, 1932, and steel production to 509,600 tons compared with 577,700 tons in the previous month, and 433,300 tons in April, 1932. Imports of iron and steel in April amounted to 70,900 tons and exports to 132,800 tons.

**Recording Extensometer.**—P. CHEVENARD, in "Revue Metallurg." describes the construction and operation of a recording extensometer for determining the tensile properties of metals at various temperatures and over long periods.

XUM

# Prevention of Porosity in Castings.

By John A. Smeeton, M.I.Mech.E.

For many years there have been in the JOURNAL various references to the porosity and openness in castings, due to variable cooling effects which are present whenever different sections junction against each other in any shape of castings in ferrous and non-ferrous metal. An aggravated form of porosity or draw occurs whenever bosses or lumps come into the design of such castings.

Claims have been made that by careful metallurgical control this serious and often fatal fault

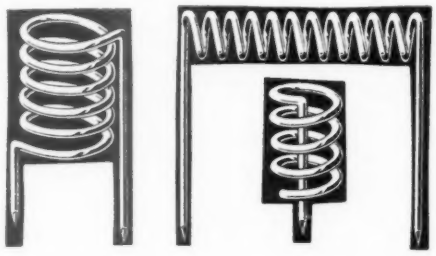

FIG. 1.—SHOWING TYPICAL DESIGNS OF COOLING SPIRALS.

can be almost, if not entirely, eliminated. Such, however, is not the case, as even with the most perfectly controlled metal poured at the correct temperature and speed, nothing can overcome the physical law by which the thinner sections of metal cool more speedily than the thicker or mass sections. The resulting prolonged cooling inevitably causes either small draw-holes, a more open-grain or porous metal at these junctions, so that where strength is aimed at, weakness and defects are invariably found.

There are various recognised cooling or chilling methods which are in general use and one of these methods has been given in detail in various articles published in the JOURNAL, written by Mr. E. Longden. This method deals entirely with mould chills inserted into the moulding sand. This form of chill is expensive to make, as such chills must be first cast and often machined to the desired shape and size. The chilling effect obtained is entirely dependent upon the thickness and solidity of the chill inserted in the mould, and a considerable amount of scientific knowledge is necessary to design and construct such chills to obtain the desired effect. In addition, such chills have to be specially designed for every particular job for which they are needed.

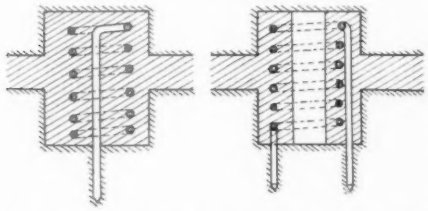

FIG 2.—SHOWING APPLICATION, DOUBLE- AND SINGLE-SPIKED COOLING SPIRALS.

In a large engineering foundry recently visited by the author such surface chills were being used in the casting of heavy flywheels, the chills being inserted opposite the arms, but as the flywheel rim was extremely heavy the only result of the surface chill was to chill the flywheel-rim surface to a considerable depth and render it almost unmachinable where the chill had taken effect. This local hardening is almost inevitable with surface chills, especially in heavy castings, and therefore they should only be used carefully and with complete understanding.

Another and somewhat crude method more generally adopted in iron and steel foundries for

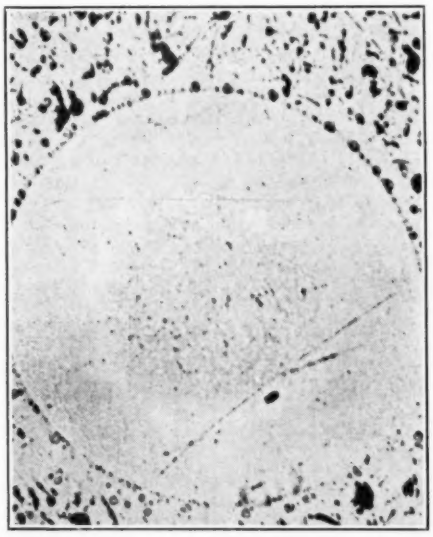

FIG. 3.—UNETCHED PHOTOMICROGRAPH OF SPIRAL EMBEDDED IN CAST IRON. × 50.

general castings is the use of iron horse-shoe nails, which are stuck into the sand wherever desired, and whilst undoubtedly these nails do cause a local cooling there is always a tendency, owing to the top-heavy shape of the nails combined with their thin points, for them to fall together during any movement of the mould or during the pouring, and they seldom, if ever, even partially melt or merge into the poured

FIG. 4.—SHOWS JUNCTION BETWEEN MILD-STEEL SPIRAL AND CAST IRON. THE SPIRAL HAS BEEN CARBURISED ABOUT MIDWAY THROUGH. ETCHED 1 PER CENT. $HNO_3$. × 50.

metal. The result is hard spots which are almost unmachinable, and this trouble is accentuated when such nails are not perfectly clean and free from all rust when used.

Some time ago a foundry manager, when passing through the machine shop of his works, saw continuous coils of steel turnings at the lathes, and it occurred to him that these evenly-turned coils might possibly be used effectively as casting denseners, and after trying them out and finding that in most cases they were too brittle, he decided to experiment further and made a number of mild-steel wire coils of suitable diameter and length to suit his particular needs.

Thus the "Perfect" spiral chilling and densening coils, as herein illustrated, were devised, and have proved completely successful in many of the largest foundries in this country.

The spirals (Fig. 1) are available in all sizes and shapes with one or two spikes of suitable length

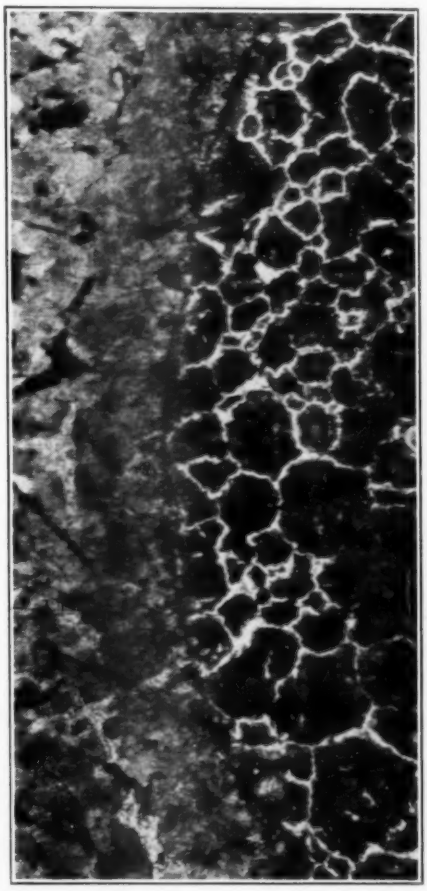

FIG. 5.—SHOWS JUNCTION BETWEEN STEEL SPIRAL AND SURROUNDING CAST IRON. THE LATTER IS FREE FROM CEMENTITE AND IS NOT CHILLED. ETCHED WITH 1 PER CENT. $HNO_3$. × 200.

to hold them firmly in the sand. For cored bosses they are made with two spikes and the coil has a diameter large enough to be fixed in a position at the centre of the cast metal and is made of approximately the same height as the boss. When bosses are not cored, then a single-spike spiral is used. In the case of a heavy boss on a very thin wall a double-spike and a single-spike spiral of different diameters can be used together, so as to obtain the special fierce cooling and densening necessary. This is shown in Fig. 2.

In the case of heavy valve flanges and valve seats, long coils are used of suitable diameter according to requirements. "Perfect" spirals and coils being evenly wound give an even-

densening effect throughout the boss or flange, or if placed in the rim of a flywheel or other wheels opposite the arms, or in the arms of a belt pulley adjacent to the thin rims, or in the bosses of pulleys, they produce the evenness of grain required and exactly where it is wanted.

Careful investigation and practical testing have proved the inadvisability of using a too thick wire, and it is better to have a thin wire forming a greater number of coils than a thicker wire of fewer coils. The extent to which these spirals will melt into the molten iron is dependent upon the pouring temperature in conjunction with the surface area of the wire and the number of coils.

Many experimental tests have been made with iron and steel at different pouring temperatures and with coils of different gauge wires, which have proved micrographically that with cast iron a thin-gauge wire is advisable, whilst with cast steel which has a much higher temperature when molten, a thicker wire is better, so that in both cases the desired densening effect is obtained, and draw-holes and porosity are prevented.

The following photomicrographs, Figs. 3, 4 and 5, have been made by a leading works' metallurgist from a casting taken at random in the making of which "Perfect" spirals had been inserted in the various bosses. The casting was broken across one of the bosses and after polishing and etching the photomicrographs were taken. It will be seen that the micros show perfect adhesion between the mild-steel spiral and the cast iron, and that the spiral is carburised about half-way through. The cast iron adjoining the spiral is quite free from cementite and is not chilled in any way, so that machinability is normal.

The report states that these "Perfect" internal denseners have fulfilled their purpose satisfactorily, as there is no sign of porosity in any of the bosses in which they have been inserted, and that the adhesion between the surface of the spiral and the surrounding cast iron is remarkably good.

The "Perfect" spirals and coils are made of special close-annealed mild-steel wire carefully coated with 100 per cent. tin to prevent metallurgical troubles and to enable the spirals to be kept free from rust. They are made in various gauges of wire to give the special fierceness of effect required for iron and steel castings suitable, for thickness differences, but in all cases the result required is obtained correctly and evenly, and no local hard spots result from their use.

They are extremely easy to fix as the spike or spikes can be made to point in any desired direction for fixing into the sand mould. Also the spikes are made sufficiently long in ratio to the diameter and length of the spiral to hold them securely in their correct position in the sand mould.

It is claimed that they solve in the most simple and inexpensive manner casting problems which have hitherto defied solution, and many thousands are now being used in the motor and engineering trade for insertion in the gudgeon-pin bosses of cast-iron motor pistons, steam-indicator bosses on cylinders, bosses on turbine castings, and wherever heavy bosses are required to be cast on to light wall sections.

Experiments are in progress with these "Perfect" spirals for use in aluminium, bronze, brass, Monel metal and other non-ferrous castings, and such spirals would be made of aluminium, copper and other suitable wire. It is expected that the results will be equally satisfactory and will enable non-ferrous founders to overcome the porosity which causes so much worry and many faulty or waster castings.

# Some Experiences with Routine Sand Testing of Green Sand.

**By John Hird.**

**The recent leader in this JOURNAL on "Sand Testing" has prompted the author to write this short Paper in an endeavour to put forward the experiences obtained in using one of the types of apparatus at present available for routine tests.**

**The apparatus used is that recommended by the American Foundrymen's Association and is built by Dietert. The lay-out is shown in Fig. 1. A fairly sensitive balance is shown on the extreme left. It is of the decimeter type and is sensitive to 0.1 gm. This is essential for obtaining consistent moisture figures from the ramming machine, which works on the principle that the same weight of sand rams closer and into less volume when wet than when dry. This has been found to be very satisfactory when the sand is correctly weighed.**

### Time Taken for Tests.

One sample is used for the three tests, and the average time is shown in Table I.

TABLE I.—*Time Schedule for Sand Tests.*

| | Secs. |
|---|---|
| Weighing sample | 45 |
| Ramming sample (taking mental note of moisture) | 13 |
| Taking permeability (and mental note of reading) | 13 |
| Stripping on post and testing for compression strength and noting reading | 13 |
| Total | 84 |

The total time, including entering of results, takes 1½ mins. This can be halved by having an intelligent boy to weigh the samples. The boy is also used for collecting the samples in tins from the various heaps and bins. It will be seen that in this way, once the samples are collected, 40 complete tests can be made in half an hour, that is, ¾ min. per test. The results are entered up on the sheet shown in Fig. 2. The sheet provides also for core-sand tests which are not included in this Paper. The numbers on the right are the machine numbers. F stands for facing sand and H for heap sand. P.M.F. is plate-moulders' facing sand, which is mixed up in three batches, 1, 2 and 3. The numbers 343, etc., are the check numbers of the various plate moulders.

### Accuracy of Tests.

It might be thought that in making the tests so rapidly a certain amount of accuracy would be sacrificed. This, however, is not so, as will be seen from Table II, which shows the tests of each of three samples. Similar figures can be obtained from any sand tested three times. I would point out that it is not the actual

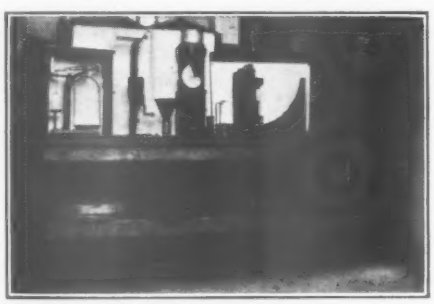

FIG. 1.—A.F.A. SAND-TESTING APPARATUS.

weighed sample rammed up three times, but three separate weighings taken from the same sample. This is of importance, as it has been found that, by ramming-up the same sample three times or more, different results are obtained, due no doubt to the "working" of the sand in ramming up. This is shown in Table III.

TABLE II.—*Showing Constancy of Test Results.*

| | Moisture. Per cent. | Permeability. | Compression strength. Lbs. per sq. in. |
|---|---|---|---|
| Sample I | 5.6 | 32 | 6.7 |
| | 5.6 | 34 | 6.5 |
| | 5.5 | 33 | 6.6 |
| Sample II | 7.2 | 30 | 7.3 |
| | 7.0 | 32 | 6.9 |
| | 7.0 | 33 | 6.9 |
| Sample III | 6.6 | 34 | 6.4 |
| | 6.4 | 35 | 6.5 |
| | 6.5 | 34 | 6.6 |

So far as the increase in the moisture figures in Table III is concerned, the first is the correct one, as the others show an increase due to the packing of the sand-grains.

TABLE III.—*Showing the Influence of Working the Sand.*

| Test No. | Moisture. | Permeability. | Compression. strength. |
|---|---|---|---|
| 1 | 6.5 | 45 | 5.0 |
| 2 | 6.8 | 45 | 5.2 |
| 3 | 7.1 | 45 | 5.3 |
| 4 | 7.2 | 43 | 6.0 |
| 5 | 7.2 | 40 | 6.2 |
| 6 | 7.2 | 40 | 6.2 |

### The Effects of Sieving on Test Results.

If a batch of sand be taken direct from the mill and a sample taken and tested, then the remainder of the batch put through a ½-in. sieve and a sample again tested, there will be a distinct difference in test results. If this procedure is continued through ¼-, ⅛- and $\frac{1}{16}$-in. sieves a definite increase in permeability is noticed, due, no doubt, to the breaking-up of the sand grains. A loss of strength is also noticed which is not so easily accounted for. Proof of this will be seen in Table IV.

When considering test results it is important to know the previous history of the sand, as a sand just milled will give a much larger permeability and greater strength than that which has been through sieves or an aerator.

TABLE IV.—*Influence of "History" on Sand Tests.*

| | Moisture | Permeability. | Compression strength. |
|---|---|---|---|
| As milled | 6.5 | 28 | 7.4 |
| Milled sand put through ½-in. sieve | 6.6 | 32 | 6.9 |
| ½-in. sand put through ¼-in. sieve | 6.6 | 35 | 6.6 |
| ¼-in. sand put through ⅛-in. sieve | 6.4 | 37 | 6.2 |
| ⅛-in. sand put through $\frac{1}{16}$-in. sieve | 6.4 | 40 | 5.7 |
| As milled put through $\frac{1}{16}$-in. sieve | 6.5 | 32 | 5.4 |

### Tensile Strength.

The fact that when drawing a moulding box off a pattern plate a tensile strain is set up on the sand and not a compression strain, which is the stress usually tested for, led the author to develop the Grubb tensile testing machine illustrated in Fig. 3 and to test sand with both compression and tensile machines in an endea-

vour to decide on the better method. That there is a difference seemed certain, as it was found that a sand which would not lift on a moulding machine and gave, say, 6.5 lbs. per sq. in. on compression, would, after adding extra red sand to it, giving it a turn and putting through a ¼-in. sieve (without re-milling), lift on the job in question and actually gave a lower compression reading when tested. The tensile test also showed a decrease, as will be seen in Table V.

**SAND TEST REPORT**

Cast No. .....

Date .....

| SAMPLE | MOISTURE | PERMEABILITY | COMPRESSION | TENSILE | SAMPLE | MOISTURE | PERMEABILITY | COMPRESSION | TENSILE |
|---|---|---|---|---|---|---|---|---|---|
| P.M.F. 1 | | | | | No. 1 m/cF | | | | |
| P.M.F. 2 | | | | | No. 1 m/cH | | | | |
| P.M.F. 3 | | | | | No. 2 m/cF | | | | |
| 343 | | | | | No. 2 m/cH | | | | |
| | | | | | No. 12 m/cF | | | | |
| | | | | | No. 12 m/cH | | | | |
| | | | | | No. 13 m/cF | | | | |
| | | | | | No. 13 m/cH | | | | |
| | | | | | Pistonm/cF | | | | |
| Red Sand | | | | | Pistonm/cH | | | | |

| DRY CORE SAND | PERMEABILITY | SHEAR | TRANSVERSE | DRY CORE SAND | PERMEABILITY | SHEAR | TRANSVERSE |
|---|---|---|---|---|---|---|---|
| B.C.7. | | | | SS9 | | | |
| D.X.O. | | | | D.6 | | | |
| B.O.D.X. | | | | | | | |

FIG. 2.—METHOD OF ENTERING-UP SAND TESTS FOR CONTROL PURPOSES.

TABLE V.—*Correlating the Tensile Strength with other Tests.*

| | Moisture. | Permeability. | Compression strength | Tensile strength. Ozs. per sq. in. |
|---|---|---|---|---|
| Sample I— | | | | |
| Weak sand .. | 6.0 | 35 | 6.7 | 5¼ |
| | 6.0 | 37 | 6.8 | 6¼ |
| | 5.9 | 38 | 6.5 | 6¾ |
| Weak sand + 50 per cent. milled red sand | 6.5 | 45 | 5.2 | 6 |
| | 6.4 | 45 | 5.2 | 5½ |
| | 6.5 | 44 | 5.1 | 5 |
| | AVERAGE. | | | |
| Sample II— | | | | |
| Weak sand .. | 6.0 | 42 | 5.5 | 5¼ |
| | 6.0 | 42 | 5.6 | 5 |
| | 6.0 | 42 | 5.2 | 5½ |
| Weak sand + 50 per cent. milled red sand | 6.4 | 48 | 5.0 | 4¾ |
| | 6.5 | 45 | 5.0 | 4½ |
| | 6.5 | 45 | 4.9 | 4½ |
| Sample III— | | | | |
| Weak sand .. | 5.8 | 37 | 6.7 | 7 |
| | 5.6 | 35 | 6.5 | 6¾ |
| | 5.6 | 40 | 6.5 | 6¾ |
| Weak sand + 50 per cent. milled red sand | 5.3 | 38 | 5.9 | 6 |
| | 5.4 | 37 | 6 | 6¼ |
| | 5.2 | 39 | 5.8 | 6¼ |
| Milled sand used in above tests | 7.0 | 50 | 4.5 | 4¾ |

The bad lift obtained from the sand referred to as weak sand in Table V is shown in the right-hand side of Fig. 4. On the left-hand side is the good lift from weak sand + 50 per cent. milled red sand.

It is apparent that neither test gives correct information about the "lifting" properties of sands. Although it is quite certain that compression or tensile figures give a broad indication of the lifting capabilities of the sand it will be seen that they are not really satisfactory. It is the author's wish to point out that they have their limitations, as is proved by the above tables, which are being constantly reproduced in the author's experience.

Until a more accurate system is evolved the A.F.A. test-piece as it stands at present is, in the author's opinion, the most satisfactory and easily-worked available, and although not perfect yet provides great help in the daily workings of the foundry when the results are intelligently interpreted.

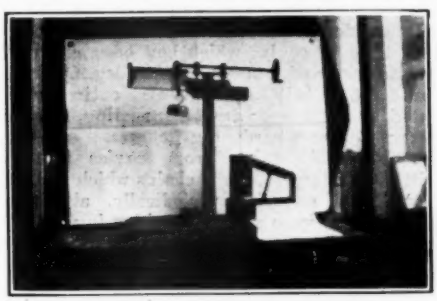

FIG. 3.—THE GRUBB TENSILE TESTING MACHINE.

FIG. 4.—BAD LIFT (RIGHT) FROM "WEAK SAND" AND A GOOD LIFT (LEFT) FROM WEAK SAND + 50 PER CENT. MILLED RED SAND.

## Better Lead Outlook.

By "ONLOOKER."

During the slump in the values of non-ferrous metals lead has suffered as badly as any, and has perhaps remained in the rut for longer periods, without even a brief rally, than either copper or zinc. In 1894 lead touched £9, but last year the sterling quotation fell to £9 3s. 9d., which, on a gold parity, was less than £7, and constituted an absolute low record for all time. Rather more than a year ago the Lead Pool broke up, and a sharp drop in the price on the London Metal Exchange followed, but the market was really all the healthier in consequence, for much artificial support had been given to this metal during the period of the pool control. One useful result of this setback in values was a contraction in the rate of output as the quotation receded to the low level above mentioned.

During the May rally in non-ferrous metal prices lead rather hung back, for speculators fought shy of this metal in the beginning, and the upward movement in the States did not seem to be reflected in London. There was, of course, an advance in sympathy with what was happening in other directions, but it was orderly and lacked the speculative flavour of the upward rush seen in copper and tin. Now, in the early days of June when a fairly general setback is occurring on the Metal Exchange lead is holding on to its gains, and there is less nervousness among consumers and holders of the metal. There has, as a matter of fact, been some speculative buying of lead, but mostly of an investment character, and no particular anxiety to get clear has been evinced by the purchasers. At the time of writing the London Metal Exchange quotation has advanced beyond £13, and the margin between spelter and lead has narrowed to £3. This is still rather wide, and there is still room for some advance in the lead quotation.

One feature of the lead situation last year, which is not being repeated in 1933, is the plethora of secondary metal, and, in consequence, with less re-melted lead about, virgin metal is coming into its own again. In the ordinary way a good deal of second-hand cable lead comes on to the market, but these are quiet times for the cable trade, and with less replacement work going on a smaller tonnage of secondary lead is becoming available. In the United States re-melted lead bulks quite largely in the tonnage becoming available year by year, a normal output from this source being anything from 200,000 to 300,000 short tons per annum.

Statistics in regard to lead are not readily available, but in view of the improvement in the rate of consumption which has taken place this year, not only in Europe, but also in the States, it seems fairly certain that the position has improved. At the end of last year stocks on hand all over the world were decidedly heavy, and this state of affairs continued during the early months of 1933, but consumption is now proceeding at such a rate as to make it fairly certain that stocks are being drawn upon, and it is this realisation which has prompted speculators to turn their attention to lead. Just how far the rise in lead can go with safety at the present time is necessarily largely a matter of conjecture, for with the Economic Conference in session the markets are subjected to much uncertainty, and rumours favourable and otherwise are bound to crop up from time to time. Given reasonably favourable developments in the political sphere, lead should advance to £15 with safety, but that appears to be far enough for the present.

That lead is a metal closely allied with the march of civilisation cannot be denied, for the metal enters into many widely divergent manufactures. Among other industries, the building trade in this country is taking up a very considerable tonnage, while the automobile industry is responsible for an excellent demand.

# The Heat-Treatment and Testing of Chains.

## A REVIEW OF RECENT INVESTIGATIONS.

By J. W. Donaldson, D.Sc.

The testing and heat-treatment of chains and other lifting gear is a subject which gives rise to a fair amount of concern to all users of chains, and has resulted in, during recent years, a number of metallurgical investigations. Chains and other types of lifting appliances are used to some extent in most industries, particularly in construction work, in engineering shops, in foundries, in shipbuilding yards, in dock processes and in railway transport. Accidents with such gear are of common occurrence, sometimes with fatal results, hence the necessity for very frequent inspection and testing to ascertain if the materials of which they are manufactured are in a satisfactory condition for service.

The Anchors and Chains Cables Act, 1899; the Factory and Workshops Act, 1901; the Coal Mines Act, 1911, and dock, building and shipbuilding regulations of various dates all specify that before new chains and other lifting gear are put into service they shall be tested under a tensile "proof load," which is in general equal to twice the safe working load. A periodical examination, and annealing of such gear while in service is also frequently specified, as well as the registration of all lifting tackle. The types of lifting appliances dealt with under these various regulations and Acts are chains, rings, hooks, shackles, eyebolts and swivels.

The brittleness of chains and the failures resulting from such brittleness, when chains are in service, has been the subject of a number of metallurgical investigations. It is a well-known fact that wrought-iron chains are sometimes extremely brittle, and there have been cases where they have been so brittle that dropping them on an unyielding surface has resulted in fracture. Brittleness is usually regarded as resulting from overstrain and fatigue producing highly crystalline material, and annealing is usually resorted to in order to remove such strains and to produce a fibrous structure. Until recently definite data relating to the annealing of chains did not exist, and the various investigations have been undertaken with the object of obtaining such data, and also to determine the influence of different factors on brittleness.

One factor in chain failures which has given rise to a difference of opinion and some discussion is the periodical proof testing of chains. There is general agreement that new chains and chains which have fractured and been repaired should be subjected to the full proof load, but various opinions have been expressed as to the advisability of testing annealed chains in the same manner. Objections to periodical proof testing are that a permanent extension results from such testing with consequent falling-off in ductility and a shortening of the life of the chain. In favour of such testing, however, there is the fact that such testing, by imposing a stretching influence, reveals incipient flaws and cracks in joints and welds. Investigations have been carried out with a view to ascertaining the effects which proof testing has on the properties of chains in setting up permanent stresses and strains and the influence which annealing or heat-treatment have on material subjected to such strains. The influence of annealing in removing the effects of cold work and in improving coarseness of grain has also been dealt with.

### Effect of Proofing and Annealing.

In 1924 a Paper was published by Mr. C. G. Lutts[1] on tests carried out in the Boston Navy Yard. Large chains manufactured of a good quality of wrought iron were tested by dropping individual links from a height of 16 ft. on to an anvil weighing 2,000 lbs. Some links were tested as received, some after being in service at sea, and some after exposure to the atmosphere. Other links as received were submitted to 150,000 repetitions of a proof load of 10 tons per sq. in. Some of these links were tested as proofed, others were annealed at temperatures varying from 600 to 960 deg. C., while others were annealed at 960 deg. C. and subsequently proofed to 10 tons per sq. in. before testing. These tests indicated that service or proofing either before or after annealing rendered the chain links brittle, due to overstraining, and that such links broke with a sharp and short fracture under shock. In the annealed links, however, this type of fracture was seldom obtained and better tests were obtained, the larger number remaining unbroken after 100 drops.

An investigation was initiated in 1924 at the instance of the Home Office by the Engineering Research Board of the Department of Scientific and Industrial Research. The work was carried out at the National Physical Laboratory, and the effect of plastic straining and periodical heat-treatment on the mechanical properties of new and old chains was studied. The chains were tested (1) as received, (2) after annealing between 650 and 750 deg. C., (3) after normalising at 1,000 deg. C., and (4) after overstraining once, twice and three times on a static-tensile machine, followed each time by annealing or normalising. A report on the investigation was first published by Dr. H. J. Gough and Mr. A. J. Murphy[2] in a Paper to the Institute of Mechanical Engineers in 1928 and then as a Special Report, No. 3, of the Department of Scientific and Industrial Research.

It was found that notched-bar test-pieces cut from links of chains which had been repeatedly overstrained and annealed at 650 deg. C. showed considerable brittleness, while entire chains tested by shock were free. Annealing, however, removed strain-hardening effects. An unannealed chain taken from service remained brittle till annealed, while chains which had been proved and annealed periodically, also taken from service, were not brittle, showing that the combined effect of overstraining and annealing had not produced brittleness. The cause of brittleness produced by service was found to be due to mechanical action and was proved by artificially producing a high state of brittleness on new chains by a series of small impacts applied by a light hammer.

The conclusions drawn from the results of this research indicated that, if failures due to gross overloading, defective composition and bad workmanship were omitted, the failure of wrought-iron chains and cables might be caused by one or more of three main types of defect. Two of these types, where a brittle state may be set up by burning or overheating during manufacture of the chain iron or the forging of the chain link, and where service shocks or strains tend to bring about a progressive deterioration of the weld which cannot be detected by proving or by visual examination, cannot be cured by heat-treatment. The third and most important cause of brittleness results from service and is produced by inter-link action or some other mechanical action to which the cable may be subjected. The material of the surface of the link becomes locally hardened, perhaps only to a small depth, but to such a degree that its ductility is practically exhausted and the link section consists then of a thin, highly-brittle case, covering a ductile core. Bending strains produced by shock cause the skin to crack and the crack penetrates to the ductile core, which, due to local constraint cannot exert its property of ductility, with the result that the crack spreads across the link and produces a fracture which has a brittle appearance. In this hardened-surface layer, recrystallisation proceeds readily at 650 deg. C., so that heat-treatment at such a temperature or normalising at 1,000 deg. C. restores the ductility of the material. It is pointed out, however, that such heat-treatment can only be regarded as a cure for surface embrittlement and is not a means of preventing subsequent redevelopments of brittleness in service.

### Effect of Low Temperatures.

Investigations were also carried out at the National Physical Laboratory[3] on the failures of chains at low temperatures. Engineers and other users of wrought-iron chains and lifting gear are particularly reluctant to use them in cold and frosty weather, due to the belief that there is a great reduction in their shock-resisting properties in such weather. To investigate this apparent frost-brittleness, samples of 13 links of ½-in. new chain were submitted to tensile-impact tests at temperatures ranging from 18 to − 78 deg. C. The impact values were found to be good down to − 30 deg. C., but at − 65 deg. C. and lower the values steadily decreased, until they were only 25 per cent. of those at ordinary temperature, while the appearance of the fracture, which was essentially ductile at −20 deg. C., became brittle at − 30 deg. C. While the results obtained suggested that the material of the links was in a highly-brittle state, the position of the failures indicated that some other factor was in operation, as failure usually occurred at the sides where the scarf of the weld ends, rather than at the crown of the link, which is in the position of the estimated maximum stress. It was suggested that the wrought iron itself might not be brittle, but that a notched-bar brittleness effect was occurring at low temperatures. It was important, therefore, to determine whether the impact strength of a notched-bar decreased more rapidly with fall of temperature than that of an unnotched bar.

Cylindrical test-pieces were made and finished by grinding from chain iron and when tested showed the material to be perfectly ductile over the range of temperature 18 to −78 deg. C. When notched specimens were tested, however, an entirely different result was obtained. The energy-temperature curve fell slowly from 200 to 15 deg. C. after which extreme notched-bar brittleness was apparent. These results showed clearly that notched-bar brittleness is developed most seriously within the narrow range of temperature between air temperature and frost temperatures in this country.

The general conclusions from these two series of tests indicate that brittleness is not produced in wrought iron at low temperatures, but that stress concentrations resulting from surface discontinuities may produce serious notched-bar brittleness. In service, therefore, serious failures may occur in chains with defective welds or in links showing surface injuries, so that all lifting gear ought to be carefully handled and frequently inspected in order to minimise damage and in order to replace defective links. Weld joints should also be carefully made and finished off.

### German Investigations.

Further work on the heat-treatment of chains to release permanent strains set up by proving was carried out by W. Pungel[4] and published in 1930. An unusual method of testing was adopted, based on the fact that wrought iron and mild steel show a sudden fall in the notched-bar impact strength over the range 100 to −80 deg. C. The temperature of the inflexion in the energy-temperature curve is influenced by cold

work and, in general, the more severe the cold work the higher the temperature of the inflexion. The effect of various degrees of deformation on chain material was determined from the temperature of inflexion by making a series of notched-bar tests on specimens cut from links after straining them under specified loads.

The chain material tested consisted of both mild steel and wrought iron. Lengths of three links were tested after normalising at 950 deg. C., after normalising and being stressed in tension to the proof load, and after being proof-tested and aged at 250 deg. C. The effect of heat-treating the proof-tested chains at 700, 950 and 1,100 deg. C. was also investigated. Test-pieces for the notched-bar test were taken in all cases both from the welded and the unwelded end of each link.

As a result of the investigations it is concluded that somewhat similar results are obtained both from mild-steel and wrought-iron chains. The strain produced by proof-loading produces a marked reduction in the impact strength of the chain and there is an increased tendency to embrittlement by ageing. It is suggested, therefore that all chains should be subjected to heat-treatment not only after proving but also after being one year in service, and that such treatment should be normalising, at 950 deg. C., as annealing at 700 deg. C. is liable to produce grain growth both in iron and steel. While alternately overstraining and annealing at 650 to 700 deg. C. can give rise to pronounced grain growth in steel with a consequent reduction in the impact value of the material, the work of Gough and Murphy has shown that wrought-iron chains, which have been regularly annealed at 650 to 700 deg. C. and proved, show no indication of embrittlement and that regular annealing at such temperature followed by proof-testing is a satisfactory procedure to adopt with such material. The British investigation also showed that although specimens cut from individual links show embrittlement after repeated straining and annealing, entire chains tested by shock were free from embrittlement. The German investigation only deals with tests from individual links and cannot therefore be taken as indicating the behaviour in service of chains manufactured from wrought iron, however it may apply to steel chains. No evidences of embrittlement due to a hard surface layer resulting from shock are given by Pungel, due, no doubt, to the fact that the test-pieces were cut from the centre of the links and surface conditions were therefore not observed.

### American Investigations.

A considerable research dealing with the effects of annealing of chains carried out under the auspices of the American Society of Safety Engineers was published in "Heat Treating and Forging" in 1931.[5] As the result of testing steel-chain stock it was shown that the fatigue resistance of the material deteriorated with annealing at 815 deg. C. and that annealing did not remove the effects of previous fatigue. Tests were made both with and without the adherent scale, but the removal of the scale did not increase the fatigue resistance to any marked extent. Tensile tests in fatigue were similar to those obtained in the original bar, and it was suggested on that account that no warning could be expected in the case of fatigue failure of chains. Tests on chain lengths annealed at 815 and 540 deg. C. and at 815 deg. after partial fatigue and tested in a repeated-loading machine gave similar results, as did also tensile tests on chain lengths. Tensile tests and fatigue resistance tests on electrically-welded steel chains were greater and more uniform than on hand-welded chains. Annealing at temperatures between 540 and 620 deg. C. on wrought-iron chains produced decreases in both fatigue resistance and tensile strength and these decreases increased with increase in annealing temperature and decrease in rate of cooling.

The results of these tests suggest that annealing is detrimental to chains whether made of steel or wrought iron. In view of other work done on similar materials, it is suggested that fatigue is not a cause of chain failure, and at the safe working load to which chains are subjected fatigue failures resulting from repeated bending of the sides of the links do not occur due to the short-link construction of most chains.

After the investigations of Gough and Murphy were published in 1928, further investigations were undertaken by the American investigators in order to reproduce the British work. The first tests on ½-in. chains did not produce surface brittleness on hammering, but brittleness was obtained subsequently on 1-in. chains. It was also found that work which produced lateral displacement in the surface layers of both iron and steel as well as compression of the layers, such as is produced by simple hammering, caused more severe embrittlement. Both iron and steel chains were embrittled by surface hammering but were restored by annealing at 750 deg. C.

The recommendations put forward by the Committee as a result of their investigation are that wrought-iron chains should be annealed at 750 deg. in preference to normalising, and that steel chains should be normalised at 900 deg. C. rather than annealed at 750 deg. C. Various times are also given for the heating of different sizes of chains and it is suggested that cooling should take place freely in air and not in enclosed pots or boxes. For detecting brittleness the end-hammering test of individual links is considered the most practical, and chains which have been repaired should be subjected to a test 10 per cent. greater than the safe working load.

### Other Investigations.

The nature of defective laminations in wrought-iron bars and chain links has also been investigated by Gough and Murphy.[6] These laminations, which have a coarsely crystalline appearance, are slightly harder and more brittle than normal iron. A particular layer examined was found to contain a high proportion of phosphorus and silicon (phosphorus 0.48 per cent. and silicon 0.38 per cent.). Microscopic examination showed no evidence of burning and heat-treatment at 1,050 deg. C., did not produce grain refinement, due to the change points being entirely depressed, as was revealed by thermal analysis. It was suggested that a defective layer resulted from abnormal puddled bars becoming worked into piles with normal bars during the manufacturing process. As a result of this investigation, a special test for such material is included in the new B.S.I. Specification for Wrought-Iron Chains.

Other investigations on chains at present being conducted at the National Physical Laboratory deal with the low-temperature annealing of steel chains and the periodical heat-treatment of calibrated chains. The inquiry into the failure of wrought-iron chains at low temperatures (down to −78 deg. C.) has been extended to the effect of low-temperature annealing on mild-steel fittings attached to wrought-iron chains and to suitable heat-treatment for mild-steel chains and lifting gear, but so far conclusive results have not been arrived at. The annealing of calibrated chains raises a serious matter which does not occur with ordinary crane chains, where a slight elongation after proofing is not too serious. Hand-made wrought-iron chains and electrically-welded mild-steel chains have been subjected to tests on a special machine, some as received and others after periodic annealing at 650 and 750 deg. C. Material tested to destruction indicated that normal working over sprockets does not induce brittleness in a chain but merely wear, whereas periodic annealing produced an extension in the pitch of the chains and consequently shortens its life. It is stated that, if the final results of this investigation confirm the data so far obtained, the practice of annealing such types of chains must receive careful reconsideration.

### General Conclusions.

It would appear that failures in wrought-iron chains, apart from failures that occur due to defective composition, bad workmanship, or overloading, result not from fatigue of the material but are due to burning or overheating of the material during manufacture of the iron or forging of the link, deterioration of the weld resulting from shocks or strains, or to inter-link or other mechanical action which sets up a state of surface brittleness. Low-temperature brittleness as revealed by notched-bar tests results from surface discontinuities in the material. Somewhat similar results are obtained in mild-steel chains.

Strain- and work-hardening effects are removed by annealing, and the combined effect of overstraining and annealing does not produce brittleness. Annealing of wrought-iron chains can be satisfactorily carried out at 650 to 700 deg. C. when there is recrystallisation of the hardened material. Steel chains should be normalised at 1,000 deg. C. rather than at the lower temperature used for wrought iron, as at such temperature pronounced grain growth may occur in steel. Where steel fittings are attached to wrought-iron chains such fittings should be removed if possible, otherwise the chains should be normalised at 1,000 deg. C. Duration of heat-treatment should vary for different sizes of chains and cooling should proceed freely in air and not in enclosed boxes.

Proofing after annealing in British practice is carried out at twice the safe working load, namely, $12d^2$, the safe working load being $6d^2$. Such a stress is not detrimental to the chain material, but produces a fair elongation of 3 to 4 ft. per 100 ft. This elongation is not serious when applied to crane chains, but is distinctly harmful when applied to calibrated chains or pitch link chains and considerably shortens their useful life, so that serious consideration is required as to whether such a test is necessary or otherwise.

For the users of chains and other lifting gear, the Home Office in 1930 issued a Memorandum on the subject by G. S. Taylor.[7] This Memorandum deals with the various types of appliances used for lifting gear, their manufacture and uses, their testing and annealing, and the question of failures, and is of extreme usefulness to engineers, foundrymen and all other users of chains and lifting gear.

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## Pig-Iron and Steel Output.

The National Federation of Iron and Steel Manufacturers states that there were 72 furnaces in blast at the end of May, an increase of three since the beginning of the month. Production of pig-iron in May amounted to 339,900 tons, compared with 324,700 tons in April and 315,300 tons in May, 1932. The production included 84,900 tons of hematite, 149,600 tons of basic, 82,900 tons of foundry, and 11,600 tons of forge pig-iron. The output of steel ingots and castings amounted to 599,600 tons, compared with 509,600 tons in April and 416,900 tons in May, 1932.

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# A New Canadian Steel Foundry.

Quebec has some of the oldest-established iron and steel plants of the Dominion, which is a natural result of the fact that it was the earliest settled part of Canada. Among these is the company now known as the Sorel Steel Foundries, Limited. This was established in Sorel in 1855 by the late Moise Beauchemin, largely for the manufacture of agricultural machinery, as agriculture was the principal occupation of the people of the province.

With the introduction of steamships in place of sailing vessels, the Beauchemin shops in the port of Sorel took up the manufacture of marine engines and boilers, under the firm name of Beauchemin & Fils. It is interesting to note that one of their marine engines built in 1876 is still in operation in the ferry "Sir Henry of Montreal," which plies across Lake St. Louis between Lachine and Caughnawaga. During this period the firm also made and installed the waterworks plant for Sorel. Meantime the manufacture of agricultural implements had been largely extended to meet the growing demand.

### Evolution of the Foundry.

In 1902 the firm became a limited company, but still was an entirely family affair. The foundry facilities were extended by the addition of a Tropenas (side-blow) two-ton converter for the production of steel castings. Gradually the agricultural lines gave place to a wide range of railway and marine castings in steel and iron. More recently the alloys have been used in increasing quantities to meet the changing needs of the times, and now alloy-steel castings for dredges, steam shovels and similar purposes compose an important part of the output.

The latest phase in the development of this company to keep up with the times is marked by a completely new and modern steel foundry, with a new name, Sorel Steel Foundries, Limited, which marks a change of ownership from the Beauchemin family to an industrial group with wide interests throughout Eastern Canada. Consolidated Marine Companies, Limited, is the holding company for this group, which includes, besides Sorel Steel Foundries, the General Dredging Contractors, Limited, the Sorel Mechanical Shops, Limited, and the Manseau Shipyards, Limited.

With the new name came a change of management, and P. H. Desrosiers, who had been for a number of years with Joliette Steel, Limited, was appointed general manager, and along with several of his technical associates reorganised the company and made the plant improvements described below.

### The New Plant.

The new plant was designed by Frank D. Chase, Inc., of Chicago, B. G. Flaherty, of Montreal, being the resident engineer, and G. R. Milne superintendent of construction.

The foundry now consists of a structural steel building, 200 ft. by 90 ft., set on a reinforced concrete foundation. About 60 per cent. of the wall space is glazed, and this, in conjunction with a modern system of interior illumination, gives an unusually well-lighted foundry floor. A new railway siding has been built, running directly into the plant. As a considerable amount of excavation was necessary in making this siding, the waste was used to construct a wharf, 200 ft. in length, so that the plant is now served with the best possible facilities for transportation by rail and water.

The plant now consists of a central bay, 200 ft. by 45 ft., which contains the dry-sand moulding floor, electric furnace, mould ovens, sand blast, annealing furnaces and cleaning equipment. Off this main bay extends a side bay, 100 ft. by 50 ft., which is used for green-sand moulding.

The plant is adequately served by three overhead travelling cranes, the two over the main bay being of 10 and 7½ tons capacity, while the crane over the materials storage and shipping is of 10 tons capacity.

The production equipment consists essentially of the electric melting furnace, modern mould- and core-drying equipment, annealing furnaces, quenching tank, and complete cleaning equipment to finish economically alloy-steel castings. The plant is thus prepared to produce a wide range of steel castings. The principal items of equipment will be described separately in detail.

### 'Lectromelt Furnace.

The new furnace was built by Dominion Engineering Works to the order of Canadian 'Lectromelt Furnace Company. Its rated capacity is 1½ tons an hour. As it is used largely to make manganese steel from scrap of variable composition which requires refining, a basic bottom has been installed. Plain carbon steels and other alloys containing nickel, chromium, vanadium and molybdenum are, of course, made with equal facility on the basic bottom, the balance between cost and quality being in favour of the basic as compared with the acid bottom under the company's operating conditions.

The transformer, of 1,500 k.v.a. capacity, was made by Packard Electric Company at St. Catharines, Ontario, and is of multi-voltage type with adjustable reactance which takes a 60-cycle current supplied at 30,000 volts and transforms it to a voltage ranging from 53 to 138 volts, phase to neutral as may be required for economical operation. The switchboards, instruments, motors, relays, automatic regulators and other electrical accessories were furnished by Canadian General Electric Company.

The foundation of the furnace, the ladle pit, the slag pit and the transformer vault are of monolithic reinforced concrete construction, particular care having been devoted to the ladle pit to make it water-tight.

The furnace practice is varied to suit whatever steel is being made and, as a considerable variety of alloy steels is turned out in addition to plain carbon steels, the company employs an experienced staff who have at their command the resources of a first-rate chemical and metallographic laboratory.

### Moulding Shop.

The moulding shop in the main bay has been laid out with a view to making its sand conditioning and handling fully mechanised when conditions warrant. Meantime a Simpson sand-mixer has been added to the former equipment. This was built by Dominion Engineering Works and is the first of its type to be made in Canada. The mill is driven by a 50-h.p. slipring motor connected through a Dominion Farrel-Sykes speed-reducer. New drying ovens for moulds and cores have been installed, all of Coleman design and erected under the supervision of the Foundry Equipment Company, of Cleveland. The mould-drying oven is 20 ft. by 12 ft. by 10 ft. inside dimensions. The larger car type core oven is 16 ft. by 7 ft. by 7½ ft. and the smaller rack-type core oven for small cores is 13 ft. by 6 ft. by 7 ft. All ovens are of brick and steel construction, are heavily insulated, are oil-fired and have thermostatic control.

The pattern shop has been completely rebuilt and is now an efficient division of the plant, prepared to furnish patterns of any kind on short notice.

### Heat-Treatment.

As a large part of the company's products consists of castings that require special heat-treatment, great attention has been given to the facilities for this purpose. In the main bay are two annealing furnaces with quenching tank, conveniently located for quenching both heavy and light manganese steel castings.

The larger annealing furnace is an oil-fired Stewart furnace of car type, supplied by the Flexible Shaft Company, of Toronto. It is 15 ft. long, 7½ ft. wide and 8 ft. high. It is equipped with North American oil burners and a Sturtevant blower. The temperature is controlled and recorded by a Brown potentiometer which is actuated from thermocouples placed at six different spots in the furnace, thus ensuring an even distribution of heat throughout the interior.

Near the annealing furnace is a quenching tank of reinforced concrete, 15 ft. by 20 ft. by 13 ft. in size. The inlets and outlets are so placed as to ensure a constant flow of cold water throughout the tank, thus providing for an even cooling action when a large casting is immersed.

The castings are finished when required by sand-blasting and grinding, the machines for these purposes being conveniently located in the main bay near the heat-treating furnaces. High-speed swing grinders are provided for the larger pieces and stationary grinders for the smaller, all being of the latest types.

### Compressor.

Compressed air for sand-blasting and the operation of pneumatic tools is supplied by a new Canadian Ingersoll-Rand compressor of 750 c.f.m. capacity. This and other plant service equipment are housed in a separate brick wing. The compressor is direct-connected to a 150-h.p. synchronous C.G.E. motor with 80 per cent. leading power factor which helps to bring the power factor of the total load of the plant back towards unity. The compressor is equipped with 5-step control, which automatically adjusts the valves so as to compress whatever quantity of air is required for use. This device reduces the amount of power being used when only part of the full load is required. Considering the synchronous motor with corrective power factor and the 5-step control, this compressed-air unit exemplifies the utmost in economical operation.

The motor-generator set to provide direct current for the welding outfit and the crane motors is in the compressor room. It consists of a 50-h.p. motor between two generators providing direct current at the two voltages required for the separate purposes.

From this description it is obvious that the reconstructed plant of Sorel Steel Foundries is in a position to turn out a wide variety of steel castings. It draws from the Shawinigan Water & Power transmission system the cheap power required for the economical operation of an electric furnace plant. It has excellent facilities for assembling its raw materials and distributing its products both by rail and by water. It is located in an industrial area that offers a good local market and through its associate companies it has an exclusive market for a part of its products. This assured market gives the company a good basis for seeking business in competitive fields throughout a wider area, embracing the Atlantic and St. Lawrence seaboard of Canada, the Great Lakes and the mining regions of the north.

The company has recently been instrumental in manufacturing equipment that was previously imported, examples being the 8-yd. dredge dipper and the 1-yd. all-manganese steel dragline bucket. It has also been actively engaged in building up an export business and recently has completed a shipment of manganese-steel wearing parts consisting of ball-mill liners and jaw plates to a mine in Central America.—"Iron and Steel of Canada."

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**Expansion Diagrams of Pig-iron.**—In the "Revue de l'Industrie Minerale," J. SEIGLE and M. MATHIS reproduce a number of diagrams in which the expansion of various pig-irons is plotted against the temperature, measurements being made with the extensometer of Chevenard.

# Nitrogen in Iron-Carbon Alloys.

By W. F. Chubb, B.Sc.

Of recent years attention has been directed to a close study of gases in metals, but researches into their influences upon properties and foundry practice have not been restricted to non-ferrous metals. In the ferrous alloys it was noted long ago that considerable quantities of gas could be extracted from solidified iron-base alloys even after treatments devised to de-gas the molten material, and it seems clearly established from these early observations that our present knowledge of the behaviour of metals will undergo modifications of a far-reaching nature when the influences of this gas content has been fully understood. In particular this will be felt in our knowledge of equilibrium conditions in both ferrous and non-ferrous systems.

### Earlier Researches.

Most of our understanding in this branch of scientific achievement has been derived from the study of materials which upon further consideration must have contained appreciable amounts of gas, either in dissolved condition or in the occluded and mechanically-held state, although these possibilities were not envisaged at the time. It is not surprising that subsequent work has revealed the important fact that the materials

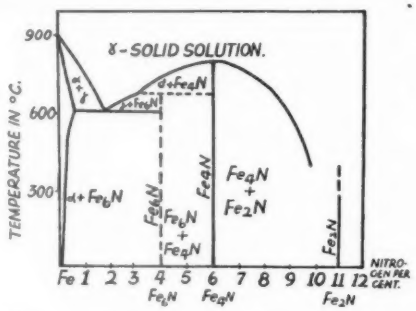



FIG. 1.—CONSTITUTIONAL DIAGRAM OF THE IRON-NITROGEN ALLOYS.

used in developing the iron-carbon equilibrium diagram, for instance, contained gases, chiefly oxygen and nitrogen, and consequently doubts of great import must of necessity now fall upon the results of those earlier researches. Much of the work from which this knowledge was derived was carried out upon alloys prepared from electrolytic iron and Armco iron, as the purest forms available, but analyses show that these materials are not free from gaseous impurities even after vacuum melting. Armco iron, indeed, may contain as much as 0.06 per cent. of oxygen, and even acid-washed electrolytic iron, after vacuum-melting, may contain 0.01 per cent. of that element. The case of nitrogen is essentially similar. Indeed, so strong have been some of the doubts expressed concerning present-day knowledge of equilibrium conditions that it has even been suggested that if iron could be produced entirely free from gaseous impurities no thermal transformations would be exhibited in a heating and cooling cycle. Furthermore, it is suggested that these thermal arrests are due chiefly to oxides and nitrides and that certain age-hardening tendencies in alloys of very low carbon content arise from these impurities. Having regard to all the facts, however, the present author considers that these claims are an exaggerated overstatement of the case, while at the same time believing that research should concentrate upon securing as accurate data as possible from the purest materials that metallurgical science can provide.

In discussing the influence of nitrogen upon iron-carbon alloys, the question is perhaps best considered from two main standpoints, namely, its relation to the thermal equilibrium diagram and its influence upon physical and mechanical properties.

### Constitution.

An examination of the research results published in the various metallurgical journals reveals how incomplete is general understanding of thermal equilibrium conditions, nor is it certain or clearly established in what form or forms nitrogen may exist. Three nitrides of iron have been reported, although the researches upon which these statements have been based are open to at least some genuine criticism, and the latest work indicates the existence of three definite compounds corresponding to the formulæ $Fe_2N$, $Fe_4N$ and $Fe_6N$. This work, due to Epstein, Cross and their collaborators in America, has given us an equilibrium diagram modified from that originally presented by Sawyer and Fry, who established two eutectic horizontals at the high nitrogen end of the diagram. It is now clearly demonstrated from further thermal analyses, supported by microscopic examinations and X-ray study, that the upper horizontal in Sawyer and Fry's diagram is a peritectoid reaction and not a eutectoid transformation as was at first believed. In the specimens prepared, three nitride layers were observed as outer, intermediate and inner layers in nitrided samples, these layers corresponding to the formulæ given above.

One of the greatest difficulties in the preparation of these specimens has been that of securing and maintaining a uniform nitrogen content in the metal. Now, most of this work has been conducted upon samples of electrolytic iron and Armco iron nitrided at various temperatures, followed by a diffusion treatment to equalise nitrogen content. The initial penetration of nitrogen is, however, a very slow process, particularly at low temperatures, as will be observed in the curve of Fig. 2 due to Eilender and Meyer. Such diffusion treatments as have been devised seem incapable of providing specimens of uniform nitrogen content, thus adding to the difficulties of subsequent determinations.

Another source of error lies in the unavoidable presence of oxygen, and this may account for or contribute to the age-hardening observed in nitrogen-bearing irons. It is claimed, however, that removal of nitrogen from irons of low carbon content is effective in eliminating this tendency after the age-hardening treatment and that microscopic examination points during quenching to the removal of the pre-existing nitrogen needles. In support of these claims it is further argued that Armco Iron does not show any tendency in this direction after annealing for 12 hrs. at 1,100 deg. C. in hydrogen gas, even after cold working. It must be remembered that any such annealing treatment will remove at least some oxygen and carbon, and as the former of these two elements is usually present in far larger amounts than nitrogen, it may have an important bearing upon this phenomenon.

Probably the most important work undertaken upon this question of nitrogen in iron alloys is that due to Koster, published in 1930. The results of this work have established the existence of nitrogen in supersaturated solid solution even after very slow cooling. In addition, it has been revealed that separation can only occur after prolonged periods of heating at a relatively low temperature and heating to 100 deg. C. for 14 days is stated to be effective in removing nitrogen completely. This total elimination may amount to as much as 0.01 per cent. in irons containing that amount of nitrogen, and this is probably the limit of solubility of the element in commercial irons and steels. However, the removal of this percentage of nitrogen in this manner is accompanied by important changes in physical and mechanical properties, for an increase of 3.2 gauss in coercive force has been reported with, at the same time, a large decrease in specific electrical conductivity amounting to 0.0013 ohms per sq. mm./m. As to mechanical properties an average decrease of 1.5 tons per sq. in. has been noted together with a considerable increase in torsional strength of as high as 25 per cent. of the original value. Furthermore, it would seem probable that nitrogen plays an important part in corrosion problems, for, with the changes in mechanical properties as reported above, the removal of nitrogen by prolonged heat-treatment is accompanied by a definite advance in the rate of solution in acids.

From these results it seems clearly established that nitrogen plays an important part in the behaviour of iron-carbon alloys in all their manufacturing stages, but these results are masked in value by many practical difficulties, not the least of which is that of its analytical determination. Many of the discrepancies observed would appear to have resulted from that cause, but Oberhoffer and his collaborators in Germany, as well as Jordan and Herty in America, have made careful study of the many analytical methods available, both suggested and tried. Accurate methods are

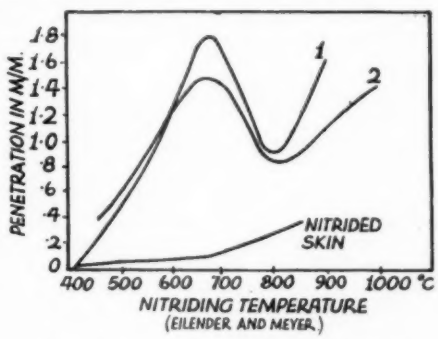



FIG. 2.—NITROGEN PENETRATION INTO ELECTROLYTIC CAST IRON.

now available for determining nitrogen in ferrous alloys, and, although they are tedious, they are becoming more suitable for general laboratory use. It is open to question, however, whether determinations of this element will become a routine laboratory duty, or whether any useful purpose can be served by including it in material specifications. At the same time, nevertheless, it may confidently be expected that further research will lead to important advances in our knowledge of equilibrium conditions in iron-carbon alloys.

## Steel Import Duties.

Sir John Field Beale, presiding at the annual meeting of Messrs. Guest, Keen & Nettlefolds, Limited, at Birmingham recently, dealt with the Government's attitude towards protection of the steel trade. He said the duty of 33⅓ per cent. imposed on steel had been found inadequate, and the National Committee of Steel Manufacturers had advised a temporary increase. The Import Duties Advisory Committee did not act on this advice. At any time, since the passing of the Imports Duties Act, the Government could have put an end to the dumping of steel by a stroke of the pen. The duties had not produced conditions in which progress could be made with reorganisation, but they had been helpful. They could be thankful that the country had finally abandoned its Free Trade policy. As the use of duties became better understood and an effective tariff structure was built up the country would increasingly feel the benefit of the change of policy.

# This Week's News in Brief.

## Trade Talk.

Chrome-steel tram rails are being tried out in Leeds.

Ullcoats iron-ore mine at Egremont, Cumberland, was reopened recently, after being idle for about a year.

The Vitkovice Ironworks, Czecho-Slovakia, one of the leading concerns of its kind in Central Europe, has just put 30 coke-ovens into operation.

The Imperial Steelworks of Messrs. Edgar Allen & Company, Limited, Sheffield, were visited on June 14 by 60 members of the Staffordshire Iron and Steel Institute.

For two years only one department of the works of the Sulphide Corporation, Limited, at Seaton Carew, Durham, has been in operation. On July 1 another department is to be reopened.

By courtesy of the White Star Line, members of the Manchester Association of Engineers will visit the motor vessel "Georgic" at Gladstone Dock, Liverpool, on Thursday, June 29.

The registered offices of Messrs. Coleman Foundry Equipment Company, Limited, are being removed from 14, Southampton Street, to 156, Strand, London, W.C.2, as from June 24.

Plans have been approved by Leven Dean of Guild for extensive erections to be made at the Durie Foundry of Messrs. Henry Balfour & Company, Limited, engineers and ironfounders, Leven.

Beralt Tin & Wolfram, Limited, have appointed Messrs. Bessler, Waechter & Company, Limited, Salisbury House, Finsbury Circus, London, E.C.2, sole selling agents (home and export) for their ferro-tungsten.

There are prospects that the Cardonnel Tinplate Works, Skewen, Neath, which usually employ some 250 men, will restart in the first week of July, after being idle for some eighteen months. The works consist of four mills.

The steel plant at the works of Messrs. Steel, Peech & Tozer, Rotherham, is on full-time working. Three shifts a day, each of eight hours, are being worked. The works form part of the organisation of the United Steel Companies, Limited.

The firm of Messrs. Barr & Stroud, Limited, Anniesland, Glasgow, and their employees have contributed in equal proportions the sum of £142 to Glasgow and West of Scotland hospitals and charitable institutions during the half-year ended May 31.

It is reported that a contract for two dredgers for Spanish owners are to be built by Messrs. Fleming & Ferguson, Limited, Paisley, although the firm have not yet received confirmation of the order. A number of patternmakers have, however, been engaged.

The members of the staff social club of Messrs. R. & A. Main, Limited, Gothic Iron Works, Falkirk, held their annual outing on June 11, when a large party travelled to Oban. The arrangements, under the direction of Mr. Charles M'Lean, met with universal approval.

Figures issued by the Ministry of Labour on Tuesday show that during last month the number of the registered unemployed fell by 114,755 to 2,582,879. Last month the estimated number of employed persons rose to 9,657,000, and since January the number of the employed has increased by 372,000.

The National Committee of the Amalgamated Engineering Union, at its annual conference at Blackpool, declined to rescind a declaration of the conference at Southport in 1928 relating to Communist activities. The declaration repudiated the attempts of hostile bodies to create dissension in the Union.

An order for eight Albion Valkyrie 32-36-passenger chassis with heavy-oil engines has been received by the Albion Motors, Limited, Scotstoun, Glasgow, from the Bombay Electricity Supply & Tramways Company. The chassis, which are to be mounted on 8¼-in. low-pressure tyres, are being made in Glasgow; the bodywork is to be made in Bombay.

The first launch from the Blythswood Shipbuilding Company's yard, Scotstoun, Glasgow, has taken place last week, when a dredger built for the James Towage, Dredging & Transport Company, Limited, London, was put into the water. The machinery for the vessel, which is named "Foremost Prince," will be supplied by Messrs. Aitchison Blair, Limited, Clydebank.

At the works of the North British Aluminium Company, Fort William and Kinlochleven, preparations are being made for the production of metal on a large scale. At present 50 furnaces, producing round about 90 tons of metal per week, are in operation, and an additional 20 furnaces will be in operation in the course of the next few weeks. Kinlochleven works, which have been on minimum output for the past two years, are commencing on full production.

At the Dean of Guild Court, Grangemouth, Scottish Oils, Limited, have been granted permission for an extension of their works. The plans provide for the erection on the north side of Bo'ness Road and the east side of King Street of a pump house for filling shed and two tanks, each 35 ft. and three of 26 ft., and also a furnace for the burning of sludge. The Dean, in granting the petition, said the news of the extension would be welcomed by dockyard workers in general and riveters in particular.

Messrs. Davy Bros., Limited, of Sheffield, have received a contract from the Towarzystwo Starachowickich Zakladow Gorniczych S.A., of Poland, for a high-speed forging press of 2,000 tons power operated by air-hydraulic intensifier ("Davy" patent system). It will be arranged for working also at 1,000 tons power, and will have a large baseplate extension for hollow-forging work. In addition, the press is to be equipped for certain piercing operations and will represent the latest design of press for general forging work.

We understand that Messrs. Davidson & Company, Limited, Sirocco Engineering Works, Belfast, have secured the first order yet placed for an "Aeroto" (trade mark) mine ventilating-fan equipment to be installed in a British colliery. The unit will have a capacity of approximately 100,000 cub. ft. of air per min. "Aeroto" fans are particularly well suited for mine ventilation in view of their advantages of reversibility, high and sustained operating efficiency, a non-overloading power characteristic and capacity to deal with relatively wide variations in the equivalent orifice of the mine.

## Company Reports.

**Whessoe Foundry & Engineering Company, Limited.**—Dividend of 5 per cent. for the year to March 31 last.

**International Nickel Company of Canada, Limited.**—Quarterly dividend of 7 per cent. per annum on par value of the preferred stock.

**Electric Furnace Company, Limited.**—Net profit, £5,920; brought in, £1,154; interim dividend of 3½ per cent. on the cumulative preferred ordinary shares, £2,807; final dividend of 3½ per cent. on the cumulative preferred ordinary shares, £2,878; carried forward, £1,389.

**Bradley & Foster, Limited.**—Net profit, £8,878; provision for taxation, £3,031; to depreciation reserve fund, £3,500; brought in, £2,057; dividend on the cumulative preferred ordinary shares up to March 31, 1933, at 7½ per cent., £206; dividend on the ordinary shares at 2½ per cent., £937; carried forward, £3,261.

## Contracts Open.

**Cairo,** July 12.—C.I. pipes, for the Director-General, Main Drainage Department, Cairo. The Inspecting Engineer to the Egyptian Government, 41, Tothill Street, London, S.W.1.

**Brisbane,** August 9.—Steam pipes and pump-house equipment, for the City Electric Light Company, Limited, Brisbane. The Department of Overseas Trade. (Reference G.Y. 12,667.)

**Croydon,** June 28.—Supply and erection of 48-in. dia. circulating water piping, valves, etc., for the Corporation. The Chief Engineer and General Manager, "Electric House," 38, High Street, Croydon. (Fee £1 1s., returnable.)

**Croydon,** June 28.—Motor-driven circulating water pump of 1,200,000 galls. per hr. capacity, for the Corporation. The Chief Engineer and General Manager, "Electric House," 38, High Street, Croydon. (Fee £1 1s., returnable.)

## Personal.

It is pleasing to announce that Dr. Guido Vanzetti, of the Vanzetti Steel Foundry Company, of Milan, is in England, and was present at the opening of the Cardiff Conference of the Institute of British Foundrymen.

Mr. Claude Taylor, director of the British Industries Fair, has had conferred upon him by the King the decoration of C.V.O. Mr. Taylor has been associated with the Fair from its inception in 1915, first as secretary, and since 1932 as director.

Sir Martin John Melvin, J.P., has been awarded a baronetcy on the occasion of the King's birthday. Sir Martin Melvin, who is well known in Birmingham, is chairman of Messrs. Ingall, Parsons, Clive & Company, Limited, and a director of Messrs. Charles Clifford & Son, Limited.

Mr. and Mrs. Samuel Westwood, of Wishaw, have attained the sixtieth anniversary of their wedding on June 15. Mr. Westwood, until he retired about three years ago, was foreman millwright and engineer with Messrs. John Williams & Company, Limited, Excelsior Iron Works, Wishaw.

Mr. Alexander Faulds, a young Motherwell engineer, met with a serious accident while employed in the Dalzell Steel Works of Messrs. Colvilles, Limited. He was found lying unconscious with a fractured skull and removed to the Glasgow Royal Infirmary in a critical condition.

Mr. A. Logan, chief metallurgist of Messrs. R. & W. Hawthorn, Leslie & Company, Limited, has, in addition, been appointed foundry manager, following upon the retirement of Mr. Lillie. Mr. Logan is well known throughout the North-East Coast. He is a Past-President of the Newcastle Branch of the Institute of British Foundrymen and the immediate past-chairman of the North-East Coast local section of the Institute of Metals.

At the end of the summer term, Dr. Fred Ibbotson is retiring from his position on the staff of the Metallurgical Department of the University of Sheffield, after 37 years of devoted service. It has been decided to open a subscription list and to ask all old students to subscribe. Cheques may be sent either to the treasurer of the fund, Mr. Harry Brearley, Messrs. Brown Bayley's Steel Works, Limited, Sheffield, or to the secretary, Mr. P. B. Henshaw, Messrs. Kayser, Ellison & Company, Limited, Sheffield.

### Wills.

| | |
|---|---|
| Graham, R., iron moulder, Falkirk ... | £515 |
| Robb, George Campbell, sole proprietor of Messrs. James Carrick & Sons, Hillside Foundry, Cupar, Fife ... ... | £3,201 |
| Moyers, W. W., of Liverpool, for many years managing director of Messrs. H. A. Watson & Company, metal brokers ... ... ... ... ... | £74,684 |

## Obituary.

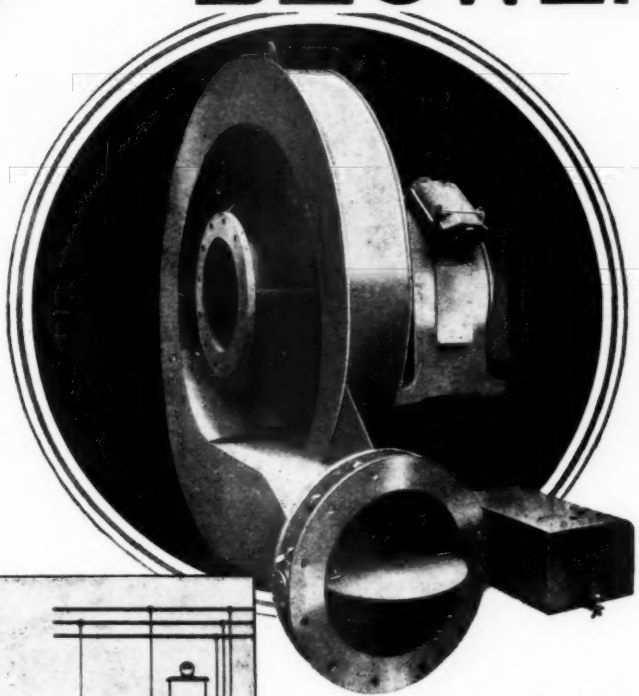
Mr. Robert Huntley, managing director of Messrs. Robert Huntley, Limited, iron and steel merchants, has died at his residence, 32, Oxford Street, Sheffield, at the age of 83.

Mr. H. R. G. Bayley, of Myford House, Horsehay, Shropshire, a director of the Horsehay Company, Limited, engineers and ironfounders, died on June 9, aged 73.

Major Godfrey Mark Palmer, the youngest son of the late Sir Charles Mark Palmer, Bt., founder of Messrs. Palmers Shipbuilding & Engineering Company, Limited, of Jarrow-on-Tyne, died suddenly in Paris on Monday, June 12, at the age of 54. Major Palmer was chairman of the Marley Hill Chemical Company, Limited, and managing director of Messrs. John Bowes & Partners, Limited, colliery owners, in both of which concerns his half-brother, Sir A. M. Palmer, Bt., is a director. He was also chairman of the Chislet Colliery, Limited, Kent. In January, 1910, Major Palmer entered Parliament as member for the Jarrow Division, and held the seat till 1922. From 1917 to 1920 he was Parliamentary Private Secretary to Sir Eric Geddes as First Lord of the Admiralty, Minister without portfolio, and Minister of Transport. He had travelled widely in the Far East, India, Australasia and America. He was a Justice of the Peace for the North Riding of Yorkshire, and was a member of the Executive Board which is responsible for the carrying-out of the Coal Mines Scheme in Durham.

XUM

# B T-H CUPOLA BLOWERS



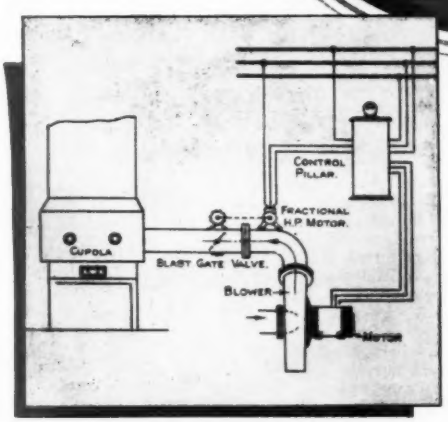



Diagram showing arrangement of Cupola Blower, Motor and Control Equipment.

## CONSTANT AIR WEIGHT

The control panel automatically operates the blast-gate valve so that a constant weight of air is delivered to the cupola irrespective of atmospheric conditions, or resistance through the cupola.

**The results are :—**

**Improved efficiency of the melting operation.**

**Higher grade castings.**

**Low coke consumption.**

**Less wear and tear of the cupola.**

**Reduced power consumption.**

## WRITE FOR FULL PARTICULARS

**BTH RUGBY**

THE BRITISH THOMSON-HOUSTON COMPANY LIMITED, RUGBY, ENGLAND A 1424

# Raw Material Markets.

The iron and steel markets maintain a fair rate of activity, particularly as regards home buying. International commerce is still under a cloud, although overseas markets linked with sterling are showing more interest in British iron and steel products. The progress of the London Conference is being anxiously watched in this connection. The publication of the May statistics of the production of steel ingots and castings in this country had a heartening effect. The figures show a total output of 599,600 tons, which is only 11,000 tons below the monthly average during 1930.

## Pig-Iron.

**MIDDLESBROUGH.**—The position in the Cleveland iron market is gradually improving. Orders are coming in more freely, and stocks are being drawn upon to meet the current demand. The present output, however, is limited, as there are only two furnaces making foundry and forge for the open market, the output amounting to about 6,000 tons per month. In these circumstances, the early relighting of additional plant is not improbable, although several of the Cleveland ironmasters are known to be in favour of raising the present "uneconomic" level of prices. Exceptionally low quotations continue to be made on the export side. The home schedule remains as follows:—No. 3 Cleveland G.M.B. foundry grade, delivered Middlesbrough area, 62s. 6d. per ton; delivered Glasgow area, 62s. 9d.; delivered North-East Coast, 64s. 6d. per ton. For No. 1 foundry iron 2s. 6d. more, and No. 4 foundry and No. 4 forge grades 1s. less, is quoted.

There is a fairly steady demand for East Coast hematite, and the output is just about being marketed. Quotations are unchanged at 59s. for East Coast mixed numbers and 59s. 6d. for No. 1 quality.

**LANCASHIRE.**—The rate of delivery of pig-iron into consumption is now well up to the improved pre-holiday level, and there are indications of further expansion, particularly in regard to deliveries to light-castings foundries. Conditions in the textile-machinery trade fail to show any material improvement. Prices are maintained, with Staffordshire, Derbyshire and Cleveland brands of No. 3 on offer for delivery to users in the Manchester zone at 67s. per ton, Northamptonshire at 65s. 6d., Derbyshire forge iron at 62s., Scottish foundry at around 80s. and East and West Coast hematite at about 75s. and 80s. 6d., respectively.

**MIDLANDS.**—Light-castings makers in this district report increasing activity, although quiet conditions are reported in the heavy engineering trades. Generally speaking, the present demand for pig-iron is at a fairly satisfactory level. Not a great deal of new booking is being seen, as most of the large consumers are covered by contracts as regards the next few months. Prices are 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, Lincolnshire, North Staffordshire or Cleveland No. 3, including delivery to Birmingham and Black Country stations. As regards hematite, West Coast iron is unchanged at 84s. 6d. per ton, while Welsh and East Coast hematites are offered at from 74s. 9d. to 77s. 6d., according to tonnage and grade. No. 3 Scottish foundry iron of medium phosphorus content comes into this district for special trades at from 83s. to 85s. Other medium-phosphorus irons are offered at about 70s. to 75s., and low-phosphorus pig at from 75s. to 85s. per ton, delivered.

**SCOTLAND.**—Current business is rather poor, consumers being content to buy only for their immediate requirements—a state of mind largely encouraged by the system of fixed prices. Better activity is now to be witnessed in the light-castings industry, most of the foundries being able to work five days per week. There is no change to report in prices, the official minimum of 65s. for No. 3 foundry f.o.t. furnaces still ruling, with an extra of 2s. 6d. per ton for No. 1. For Middlesbrough iron the official quotations for No. 3 are 59s. 9d. per ton f.o.t. Falkirk area and 62s. 9d. f.o.t. Glasgow area, with No. 4 foundry at 1s. less. Other English irons are offering at 2s. 3d. per ton less than these figures.

## Coke.

Prices remain more or less stationary in the foundry-coke market. Buying is almost entirely limited to purchases to cover consumers' immediate needs. Current quotations are as follow:—Best Durham coke, 36s. 6d. to 38s.; Scottish, 40s.; Welsh coke, 30s. to 45s. per ton, according to analysis, delivered in the Midlands area.

## Steel.

Activity in the steel market is being continued longer into the summer than is usually the case, according to the official report of the London Iron and Steel Exchange. Generally the volume of business declines during the summer months and does not revive until the autumn. So far the improvement noticeable in May has been maintained during June. In the semi-finished steel department, although a certain amount of Continental material is coming in, the greater part of this is against old contracts, and new buying or foreign material is confined to small parcels for special purposes. The British works, therefore, have practically no competition to meet in their home market, and the works producing this material are well employed. Conditions in the finished-steel department are brighter, but the demand is principally on home account, and although Empire markets have shown more interest of late, general export business has been irregular.

## Scrap.

There has been a slight improvement in business in the Cleveland scrap-iron market. Ordinary metal is now quoted at about 39s. per ton and machinery metal at about 41s. There continues to be a steady demand in the Midlands, at unchanged prices. Most of the foundries in Scotland are well supplied with scrap-iron at the moment, and it is difficult to dispose of machinery cast at 48s. 6d. and ordinary metal at 43s. to 44s. Ample supplies of scrap iron are available in South Wales, but the demand is poor. Good machinery scrap in cupola sizes is slow at 48s. to 50s.

## Metals.

**Copper.**—Quotations have been at a slightly lower level than they were a week or two ago, but this is due, not so much to a general weakening of the position as to the fact that many consumers are now well covered for some little time ahead. It must be remembered that a large amount of buying has been concluded lately on behalf of consumers, both in this country and on the Continent. Prices continue to fluctuate in the United States, the position being obscured by the deflationary measures adopted by the Government. It is reported that American copper and brass manufacturers have formed a committee, in connection with the Industrial Recovery Act, which is drawing up plans for the co-ordination of the industry.

The improvement in prices has not so far seen any attempt to increase production, it being generally realised that, in view of the present narrow margin between output and consumption, any increase in supplies would soon upset the balance of the market. The larger Empire producers, at any rate, have so far made no move in this direction.

The week's prices have been as follow:—

*Cash.*—Thursday, £35 15s. to £35 16s. 3d.; Friday, £34 15s. to £34 17s. 6d.; Monday, £35 8s. 9d. to £35 11s. 3d.; Tuesday, £37 3s. 9d. to £37 5s.; Wednesday, £36 1s. 3d. to £36 3s. 9d.

*Three Months.*—Thursday, £35 18s. 9d. to £36; Friday, £35 to £35 1s. 3d.; Monday, £35 13s. 9d. to £35 16s. 3d.; Tuesday, £37 7s. 6d. to £37 8s. 9d.; Wednesday, £36 5s. to £36 6s. 3d.

**Tin.**—The position of the tin market as regards this country remains fairly good; supplies of metal are well under control and consumption is proceeding at a good rate. Nevertheless, prices have fluctuated considerably on the London Metal Exchange, and are now at a lower level. The chief cause of the decline has been the uncertainty of the dollar position, with its consequent effect upon commodity markets. A large amount of money was invested in tin, particularly in America, in anticipation of such a period of deflation as is now taking place, and it is feared that this may be thrown back upon the market.

Daily quotations:—

*Cash.*—Thursday, £221 10s. to £221 15s.; Friday, £212 2s. 6d. to £212 7s. 6d.; Monday, £216 to £216 5s.; Tuesday, £225 to £225 5s.; Wednesday, £220 7s. 6d. to £220 12s. 6d.

*Three Months.*—Thursday, £221 10s. to £221 15s.; Friday, £212 2s. 6d. to £212 7s. 6d.; Monday, £216 to £216 5s.; Tuesday, £224 15s. to £225; Wednesday, £220 10s. to £220 15s.

**Spelter.**—In their weekly report, Messrs. Brandeis, Goldschmidt state that "although there has been a fall in the price, this has not been due to any lessening of the trade demand for spelter. The market for galvanised sheets is quite good, with the exception of the Indian section, which is still unsatisfactory. The stocks of spelter in the hands of the European Cartel have declined by about 6,000 tons during May, and if this continues the market will soon be in a very healthy condition."

Price fluctuations:—

*Ordinary.*—Thursday, £16 15s.; Friday, £16 10s.; Monday, £16 10s.; Tuesday, £17 2s. 6d.; Wednesday, £17 2s. 6d.

**Lead.**—Quotations have shown a slight decline in sympathy with other sections of the metal market. "Very active conditions have for the most part obtained, but sellers have on the whole predominated, the market from time to time being subjected to some fairly heavy selling and liquidation which, with buyers less prominent, resulted in declining prices," report Messrs. Rudolf Wolff & Company. "Trade demand remains good, though some slackening in this direction is reported after the activity of recent weeks."

Daily market prices:—

*Soft Foreign (Prompt).*—Thursday, £13; Friday, £12 11s. 3d.; Monday, £12 16s. 3d.; Tuesday, £13 5s.; Wednesday, £13 3s. 9d.

## Import Duties Advisory Committee.

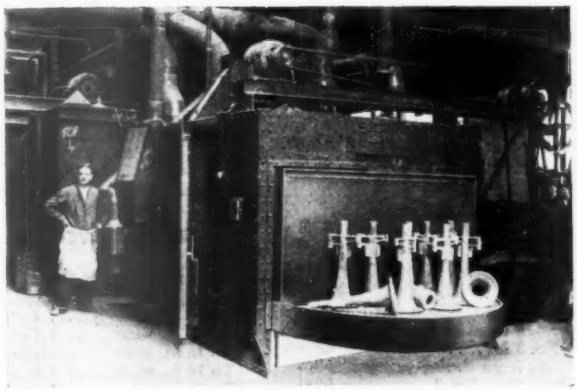
The Import Duties Advisory Committee give notice that they have under consideration an application for an increase in the import duty on wrought cased tubes of iron or steel; plates, sheets, strip, wire, rods, sections and tubes of brass and alloys of copper, other than nickel alloys; plates, sheets, strip, rods (other than wire rods), sections, wire and tubes (but not including tube shells) of copper; plates, sheets and wrought forms of nickel; ingots, billets and wrought forms of nickel alloys, other than those containing 60 per cent. or more of nickel; rolled sheets, prepared for use in printing and engraving, strip and wire of zinc.

Any representations which interested parties may desire to make in regard to this application should be addressed in writing to the Secretary, Import Duties Advisory Committee, Caxton House (West Block), Tothill Street, London, S.W.1, not later than July 17.

**Pig-iron in Belgium.**—In his report on the economic conditions in Belgium in 1932, Mr. N. S. Reyntiens, O.B.E., Commercial Secretary to H.M. Embassy at Brussels, states that production in Belgium and the Grand Duchy consists of Thomas, Spiegel and foundry iron, one furnace only in Belgium (Cockerills) producing hematite iron. Three "Sesci" furnaces in Belgium are making refined and malleable iron. No special iron is produced in Belgium as yet. The present sources of supply are Belgium, Luxemburg, Holland, the United Kingdom, Germany and France. The one Dutch furnace is supplying semi-phosphorus and low carbon pig-iron at prices even lower than those of the Belgian furnaces. Latterly the import of malleable pig-iron from the United Kingdom has diminished very considerably. The demand for foundry pig-iron is dull owing to the foundries only working two and three days per week. United Kingdom firms could increase their sales if they would alter their business methods and if they laid themselves out to understand the conditions of the market. Most of the furnaces at home sell to merchants in England who do a speculative trade in pig-iron and dispose of it to certain Antwerp dealers. The terms of payment obtained by such merchants are generally "cash against documents." The Antwerp dealers add their profit and supply the steelworks and iron foundries, giving 30, 60 and 90 days' credit, according to circumstances. The furnaces in the United Kingdom are not in contact with the consumer and rarely have an agent on the spot. In certain cases the Antwerp dealers buy from the English furnaces direct and the business goes to the furnace quoting the lowest figure. The terms of payment again are usually "cash against documents."

XUM

# TILGHMAN'S—The Originators of the SAND BLAST PROCESS



The illustrations herewith are two views of a Sand Blast Room with revolving table adapted to meet customer's requirements. This type of plant is capable of dealing with a continuous production.

**TILGHMAN'S**

**PATENT SAND BLAST Co., Ltd., BROADHEATH, Nr. MANCHESTER.**

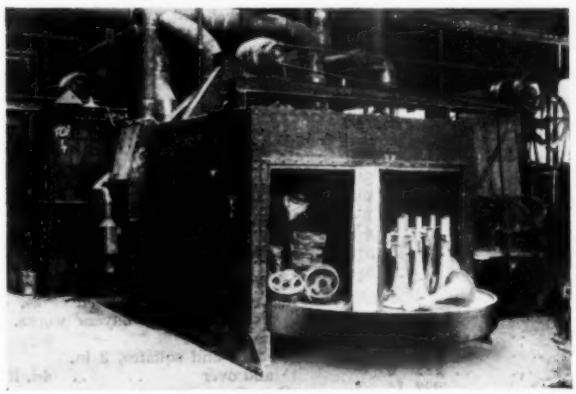
**London Office - 17, Grosvenor Gardens, S.W.1.**

19631

**MAKE SAND BLAST PLANTS TO ANY DESIGN NO MATTER WHAT YOUR REQUIREMENTS MAY BE.**

**TILGHMAN'S ARE PREPARED TO ASSIST YOU IN ANY PROBLEM IN SAND BLASTING OR ITS POSSIBLE APPLICATION TO ANY OF YOUR MANUFACTURING PROCESSES.**

*Their unrivalled experience is at your disposal —their product is ENTIRELY BRITISH.*



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# WARNER C.B.R.

**CYLINDER**

# PIG IRON

**"The brand of proved reliability"**

*Supplied to specifications covering a wide range of requirements and employed by the leading Railway Co's Roll Makers and Engineering Founders.*

**WARNER & CO. LIMITED**

**CARGO FLEET MIDDLESBROUGH**

# WEEKLY PRICE CURRENT.

## COPPER.

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 36 | 1 | 3 |
| Three months | 36 | 5 | 0 |
| Electrolytic | 40 | 0 | 0 |
| Tough | 37 | 15 | 0 |
| Best selected | 38 | 5 | 0 |
| Sheets | 68 | 0 | 0 |
| India | 48 | 10 | 0 |
| Wire bars | 40 | 0 | 0 |
| Do., July | 40 | 5 | 0 |
| Do., August | 40 | 10 | 0 |
| Ingot bars | 40 | 0 | 0 |
| H.C. wire rods | 42 | 5 | 0 |
| Off. av. cash, May | 34 | 2 | $1\frac{5}{6}$ |
| Do., 3 mths., May | 34 | 6 | $2\frac{5}{6}$ |
| Do., Sttlmnt., May | 34 | 2 | $2\frac{5}{6}$ |
| Do., Electro, May | 38 | 11 | $4\frac{5}{6}$ |
| Do., B.S., May | 37 | 2 | 6 |
| Do., wire bars, May | 38 | 19 | $5\frac{1}{6}$ |
| Solid drawn tubes | | | $10\frac{1}{2}$d. |
| Brazed tubes | | | $10\frac{1}{2}$d. |
| Wire | | | 7d. |

## BRASS.

| | |
|---|---|
| Solid drawn tubes | $9\frac{1}{2}$d. |
| Brazed tubes | $11\frac{1}{2}$d. |
| Rods, drawn | $8\frac{1}{2}$d. |
| Rods, extd. or rlld. | 5d. |
| Sheets to 10 w.g. | $8\frac{1}{2}$d. |
| Wire | $7\frac{7}{8}$d. |
| Rolled metal | $7\frac{1}{2}$d. |
| Yellow metal rods | $4\frac{1}{2}$d. |
| Do. 4 × 4 Squares | $5\frac{3}{4}$d. |
| Do. 4 × 3 Sheets | $5\frac{3}{4}$d. |

## TIN.

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 220 | 7 | 6 |
| Three months | 220 | 10 | 0 |
| English | 222 | 0 | 0 |
| Bars | 223 | 15 | 0 |
| Straits | 240 | 0 | 0 |
| Australian (nom.) | | | — |
| Eastern | 236 | 7 | 6 |
| Banca (nom.) | 239 | 0 | 0 |
| Off. av. cash, May | 186 | 5 | $10\frac{2}{3}$ |
| Do., 3 mths., May | 186 | 13 | $7\frac{1}{3}$ |
| Do., Sttlmt., May | 186 | 6 | $8\frac{2}{3}$ |

## SPELTER.

| | £ | s. | d. |
|---|---|---|---|
| Ordinary | 17 | 2 | 6 |
| Remelted | 16 | 10 | 0 |
| Hard | 14 | 10 | 0 |
| Electro 99.9 | 19 | 5 | 0 |
| English | 17 | 15 | 0 |
| India | 15 | 15 | 0 |
| Zinc dust | 19 | 0 | 0 |
| Zinc ashes | 2 | 7 | 6 |
| Off. aver., May | 15 | 11 | $7\frac{1}{6}$ |
| Aver. spot, May | 15 | 10 | $1\frac{7}{6}$ |

## LEAD.

| | £ | s. | d. |
|---|---|---|---|
| Soft foreign ppt. | 13 | 3 | 9 |
| Empire | 13 | 10 | 0 |
| English | 14 | 15 | 0 |
| Off. average, May | 12 | 4 | $8\frac{5}{6}$ |
| Average spot, May | 12 | 1 | $10\frac{2}{6}$ |

## ZINC SHEETS, &c.

| | £ | s. | d. |
|---|---|---|---|
| Zinc sheets, English | 25 | 0 | 0 |
| Do., V.M. ex-whse. | 24 | 0 | 0 |
| Rods | 30 | 0 | 0 |
| Boiler plates | | — | |
| Battery plates | | — | |

## ANTIMONY.

| | £ | s. | d. | to | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| English | 35 | 0 | 0 | to | 40 | 0 | 0 |
| Chinese | | | | | 28 | 0 | 0 |
| Crude | | | | | — | | |

## QUICKSILVER.

| | £ | s. | d. | to | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Quicksilver | 9 | 0 | 0 | to | 9 | 12 | 6 |

## FERRO-ALLOYS AND STEEL-MAKING METALS.

| | |
|---|---|
| Ferro silicon— | |
| 25% | £6 10 0 |
| 45/50% | £11 17 6 |
| 75% | £18 2 6 |
| Ferro-vanadium— | |
| 35/50% | 12/8 lb. Va. |
| Ferro-molybdenum— | |
| 70/75% carbon-free of Mo. | 6/3 per lb. |
| Ferro-titanium— | |
| 23/25% carbon-free | 9d. lb. |
| Ferro-phosphorus, 20/25% | £15 0 0 |
| Ferro-tungsten— | |
| 80/85% | 1/6 lb. |
| Tungsten metal powder— | |
| 98/99% | 1/9 lb. |
| Ferro-chrome— | |
| 2/4% car. | £25 5 0 |
| 4/6% car. | £21 2 6 |
| 6/8% car. | £21 0 0 |
| 8/10% car. | £20 0 0 |
| Ferro-chrome— | |
| Max. 2% car. | £30 0 0 |
| Max. 1% car. | £31 0 0 |
| Max. 0.70% car. | £42 10 0 |
| 70% carbon-free | $10\frac{3}{4}$d. |
| Nickel—99.5/100% | £225 to £230 |
| "F" nickel shot | £202 10 0 |
| Ferro-cobalt | 5/9 lb. |
| Aluminium 98/99% | £100 0 0 |
| Metallic chromium— | |
| 96/98% | 2/8 lb. |
| Ferro-manganese (net)— | |
| 76/80% loose | £10 15 0 to £11 5 0 |
| 76/80% packed | £11 15 0 to £12 5 0 |
| 76/80% export | (nom.) £9 15 0 |
| Metallic manganese— | |
| 94/96% carbon-free | 1/2 lb. |

Per ton unless otherwise stated.

## HIGH-SPEED TOOL STEEL.

| | |
|---|---|
| Finished bars, 14% tungsten | 2s. 0d. |
| Finished bars, 18% tungsten | 2s. 9d. |

Per lb. net, d/d buyers' works.

| Extras— | |
|---|---|
| Rounds and squares, 3 in. and over | 4d. lb. |
| Rounds and squares, under $\frac{1}{2}$ in. to $\frac{1}{4}$ in. | 3d. lb. |
| Do., under $\frac{1}{4}$ in. to $\frac{1}{16}$ in. | 1/– lb. |
| Flats, $\frac{1}{2}$ in. × $\frac{1}{4}$ in. to under 1 in. × $\frac{3}{8}$ in. | 3d. lb. |
| Do., under $\frac{1}{4}$ in. × $\frac{1}{4}$ in. | 1/– lb. |
| Bevels of approved sizes and sections | 6d. lb. |

Bars cut to length, 10% extra.

## SCRAP.

| | £ | s. | d. | to | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| South Wales— | | | | | | | |
| Heavy steel | 2 | 3 | 0 | to | 2 | 4 | 0 |
| Bundled steel and shrngs. | 1 | 17 | 6 | to | 2 | 4 | 0 |
| Mixed iron and steel | | | | | 2 | 0 | 0 |
| Heavy cast iron | | | | | 2 | 2 | 6 |
| Good machinery | 2 | 8 | 0 | to | 2 | 10 | 0 |
| Cleveland— | | | | | | | |
| Heavy steel | | | | | 2 | 0 | 0 |
| Steel turnings | | | | | 1 | 11 | 6 |
| Cast-iron borings | | | | | 1 | 2 | 0 |
| Heavy forge | | | | | 2 | 10 | 0 |
| W.I. piling scrap | | | | | 2 | 0 | 0 |
| Cast-iron scrap | 1 | 19 | 0 | to | 2 | 1 | 0 |
| Midlands— | | | | | | | |
| Light cast-iron scrap | | | | | 1 | 17 | 6 |
| Heavy wrought iron | | | | | 2 | 5 | 0 |
| Steel turnings, f.o.r. | | | | | 1 | 5 | 0 |
| Scotland— | | | | | | | |
| Heavy steel | 1 | 17 | 6 | to | 1 | 18 | 9 |
| Ordinary cast iron | 2 | 3 | 0 | to | 2 | 4 | 0 |
| Engineers' turnings | | | | | 1 | 12 | 0 |
| Cast-iron borings | | | | | 1 | 13 | 0 |
| Wrought-iron piling | | | | | 2 | 1 | 3 |
| Heavy machinery | 2 | 8 | 6 | to | 2 | 10 | 0 |

London—Merchants' buying prices, delivered yard.

| | £ | s. | d. |
|---|---|---|---|
| Copper (clean) | 28 | 0 | 0 |
| Brass | 19 | 0 | 0 |
| Lead (less usual draft) | 12 | 0 | 0 |
| Tea lead | 10 | 0 | 0 |
| Zinc | 10 | 0 | 0 |
| New aluminium cuttings | 74 | 0 | 0 |
| Braziery copper | 24 | 0 | 0 |
| Gunmetal | 22 | 0 | 0 |
| Hollow pewter | 140 | 0 | 0 |
| Shaped black pewter | 100 | 0 | 0 |

## PIG-IRON.

*(f.o.t. unless otherwise stated.)*

| | |
|---|---|
| N.E. Coast (d/d Tees-side area)— | |
| Foundry No. 1 | 65/– |
| Foundry No. 3 | 62/6 |
| ,, at Falkirk | 59/9 |
| ,, at Glasgow | 62/9 |
| Foundry No. 4 | 61/6 |
| Forge No. 4 | 61/6 |
| Hematite No. 1, f.o.t. | 59/6 |
| Hematite M/Nos., f.o.t. | 59/– |
| N.W. Coast— | |
| Hem. M/Nos. d/d Glas. | 68/6 |
| ,, d/d Birm. | 84/6 |
| Malleable iron d/d Birm. | 115/– |
| Midlands (d/d Birmingham dist.)— | |
| Staffs No. 4 forge | 62/– |
| ,, No. 3 fdry. | 66/– |
| Northants forge | 58/6 |
| ,, fdry. No. 3 | 62/6 |
| ,, fdry. No. 1 | 65/6 |
| Derbyshire forge | 62/– |
| ,, fdry. No. 3 | 66/– |
| ,, fdry. No. 1 | 69/– |
| Scotland— | |
| Foundry No. 1 | 67/6 |
| ,, No. 3 | 65/– |
| Hem. M/Nos. d/d | 66/– |
| Sheffield (d/d district)— | |
| Derby forge | 59/6 |
| ,, fdry. No. 3 | 63/6 |
| Lincs forge | 59/6 |
| ,, fdry. No. 3 | 63/6 |
| E.C. hematite | 75/6 |
| W.C. hematite | 83/6 |
| Lancashire (d/d eq. Man.)— | |
| Derby fdry. No. 3 | 67/– |
| Staffs fdry. No. 3 | 67/– |
| Northants fdry. No. 3 | 65/6 |
| Cleveland fdry. No. 3 | 67/– |
| Dalzell, No. 3 (special) | 102/6 to 105/– |
| Glengarnock, No. 3 | 82/– |
| Clyde, No. 3 | 82/– |
| Monkland, No. 3 | 82/– |
| Summerlee, No. 3 | 82/– |
| Eglinton, No. 3 | 82/– |
| Gartsherrie, No. 3 | 82/– |
| Shotts, No. 3 | 82/– |

## FINISHED IRON AND STEEL.

*Usual district deliveries for iron; delivered consumer's station for steel.*

| Iron— | £ | s. | d. | to | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Bars (cr.) | 9 | 0 | 0 | to | 9 | 15 | 0 |
| Nut and bolt iron | 6 | 15 | 0 | to | 7 | 10 | 0 |
| Hoops | 10 | 10 | 0 | to | 12 | 0 | 0 |
| Marked bars (Staffs) f.o.t. | | | | | 12 | 0 | 0 |
| Gas strip | 10 | 10 | 0 | to | 12 | 0 | 0 |
| Bolts and nuts, $\frac{3}{4}$ in. × 4 in. | | | | | 12 | 17 | 6 |
| Steel— | | | | | | | |
| Plates, ship, etc. | 8 | 15 | 0 | to | 8 | 17 | 6 |
| Boiler plts. | | | | | 8 | 5 | 0 |
| Chequer plts. | | | | | 10 | 7 | 6 |
| Angles | | | | | 8 | 7 | 6 |
| Tees | | | | | 9 | 7 | 6 |
| Joists | | | | | 8 | 15 | 0 |
| Rounds and squares, 3 in. to $5\frac{1}{2}$ in. | | | | | 9 | 7 | 6 |
| Rounds under 3 in. to $\frac{3}{8}$ in. (Untested) | 6 | 15 | 0 | & up. | | | |
| Flats—8 in. wide and over | | | | | 8 | 12 | 6 |
| ,, under 8 in. and over 5 in. | | | | | 8 | 17 | 6 |
| Rails, heavy | 8 | 5 | 0 | to | 8 | 10 | 0 |
| Fishplates | | | | | 12 | 0 | 0 |
| Hoops (Staffs) | 9 | 10 | 0 | & up. | | | |
| Black sheets, 24g. (10-t. lots) | | | | | 9 | 15 | 0 |
| Galv. cor. shts. ,, | | | | | 12 | 0 | 0 |
| Galv. flat shts. ,, | | | | | 12 | 10 | 0 |
| Galv. fencing wire, 8g. plain | | | | | 14 | 0 | 0 |
| Billets, soft | 5 | 0 | 0 | to | 5 | 12 | 6 |
| Billets, hard | 6 | 12 | 6 | to | 7 | 2 | 6 |
| Sheet bars | 4 | 15 | 0 | to | 5 | 2 | 6 |
| Tin bars | | | | | 4 | 15 | 0 |

## PHOSPHOR BRONZE.

| | Per lb. basis. |
|---|---|
| Strip | 11d. |
| Sheet to 10 w.g. | 12d. |
| Wire | $12\frac{5}{8}$d. |
| Rods | 11d. |
| Tubes | $15\frac{1}{2}$d. |
| Castings | 13d. |

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

## NICKEL SILVER, &c.

| | Per lb. |
|---|---|
| Ingots for raising | 7d. to 1/1 |
| Rolled— | |
| To 9 in. wide | 1/1 to 1/7 |
| To 12 in. wide | 1/1½ to 1/7½ |
| To 15 in. wide | 1/1½ to 1/7½ |
| To 18 in. wide | 1/2 to 1/8 |
| To 21 in. wide | 1/2½ to 1/8½ |
| To 25 in. wide | 1/3 to 1/9 |
| Ingots for spoons and forks | 7d. to 1/3½ |
| Ingots rolled to spoon size | 10d. to 1/6½ |
| Wire round— | |
| to 10g. | 1/4½ to 1/11½ |

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

## AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

| | Dols. |
|---|---|
| No. 2 foundry, Phila. | 16.34 |
| No. 2 foundry, Valley | 15.50 |
| No. 2 foundry, Birm. | 12.00 |
| Basic | 16.89 |
| Bessemer | 17.89 |
| Malleable | 17.39 |
| Grey forge | 17.39 |
| Ferro-mang. 80%, seaboard | 68.00 |
| O.-h. rails, h'y, at mill | 40.00 |
| Billets | 26.00 |
| Sheet bars | 26.00 |
| Wire rods | 35.00 |
| | Cents. |
| Iron bars, Phila. | 1.86 |
| Steel bars | 1.60 |
| Tank plates | 1.60 |
| Beams, etc. | 1.60 |
| Skelp, grooved steel | 1.60 |
| Steel hoops | 1.55 |
| Sheets, black, No. 24 | 2.10 |
| Sheets, galv., No. 24 | 2.70 |
| Wire nails | 1.85 |
| Plain wire | 2.10 |
| Barbed wire, galv. | 2.35 |
| Tinplates, 100-lb. box | $4.25 |

## COKE (at ovens).

| | |
|---|---|
| Welsh foundry | 20/– to 22/6 |
| ,, furnace | 15/– to 16/– |
| Durham and Northumberland— | |
| ,, foundry | 21/– to 25/– |
| ,, furnace | 13/3 |
| Midlands, foundry | — |
| ,, furnace | — |

## TINPLATES.

f.o.b. Bristol Channel ports.

| | | | |
|---|---|---|---|
| I.C. cokes | 20×14 per box | 17/– to 17/6 | |
| ,, | 28×20 ,, | 34/– to 35/– | |
| ,, | 20×10 ,, | 24/9 | |
| ,, | 18¾×14 ,, | 18/– | |
| C.W. | 20×14 ,, | 15/6 | |
| ,, | 28×20 ,, | 32/6 | |
| ,, | 20×10 ,, | — | |
| ,, | 18¾×14 ,, | — | |

## SWEDISH CHARCOAL IRON & STEEL.

| | £ | s. | d. | to | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Pig-iron | £6 | 0 | 0 | to | £7 | 0 | 0 |
| Bars-hammered, basis | £16 | 10 | 0 | to | £17 | 0 | 0 |
| Bars and nail-rods, rolled, basis | £15 | 17 | 6 | to | £16 | 5 | 0 |
| Blooms | £10 | 0 | 0 | to | £12 | 0 | 0 |
| Keg steel | £32 | 0 | 0 | to | £33 | 0 | 0 |
| Faggot steel | £18 | 0 | 0 | to | £23 | 0 | 0 |
| Bars and rods dead soft, st'l | £10 | 0 | 0 | to | £12 | 0 | 0 |

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

### DAILY FLUCTUATIONS.

**Standard Copper** (cash).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| June | 15 .. | 35 | 15 | 0 | dec. | 2/6 |
| ,, | 16 .. | 34 | 15 | 0 | ,, | 20/– |
| ,, | 19 .. | 35 | 8 | 9 | inc. | 13/9 |
| ,, | 20 .. | 37 | 3 | 9 | ,, | 35/– |
| ,, | 21 .. | 36 | 1 | 3 | dec. | 22/6 |

**Electrolytic Copper.**

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| June | 15 .. | 40 | 5 | 0 | dec. | 5/– |
| ,, | 16 .. | 39 | 10 | 0 | ,, | 15/– |
| ,, | 19 .. | 39 | 10 | 0 | No change | |
| ,, | 20 .. | 40 | 10 | 0 | inc. | 20/– |
| ,, | 21 .. | 40 | 0 | 0 | dec. | 10/– |

**Standard Tin** (cash).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| June | 15 .. | 221 | 10 | 0 | dec. | 5/– |
| ,, | 16 .. | 212 | 2 | 6 | ,, | 187/6 |
| ,, | 19 .. | 216 | 0 | 0 | inc. | 77/6 |
| ,, | 20 .. | 225 | 0 | 0 | ,, | 180/– |
| ,, | 21 .. | 220 | 7 | 6 | dec. | 92/6 |

**Tin** (English ingots).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| June | 15 .. | 223 | 0 | 0 | No change | |
| ,, | 16 .. | 213 | 10 | 0 | dec. | 190/– |
| ,, | 19 .. | 217 | 5 | 0 | inc. | 75/– |
| ,, | 20 .. | 226 | 5 | 0 | ,, | 180/– |
| ,, | 21 .. | 222 | 0 | 0 | dec. | 85/– |

**Spelter** (ordinary).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| June | 15 .. | 16 | 15 | 0 | inc. | 1/3 |
| ,, | 16 .. | 16 | 10 | 0 | dec. | 5/– |
| ,, | 19 .. | 16 | 10 | 0 | No change | |
| ,, | 20 .. | 17 | 2 | 6 | inc. | 12/6 |
| ,, | 21 .. | 17 | 2 | 6 | No change | |

**Spelter** (Electro, 99.9 per cent.).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| June | 15 .. | 19 | 0 | 0 | No change | |
| ,, | 16 .. | 18 | 15 | 0 | dec. | 5/– |
| ,, | 19 .. | 18 | 15 | 0 | No change | |
| ,, | 20 .. | 19 | 5 | 0 | inc. | 10/– |
| ,, | 21 .. | 19 | 5 | 0 | No change | |

**Zinc Sheets** (English).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| June | 15 .. | 25 | 0 | 0 | No change | |
| ,, | 16 .. | 25 | 0 | 0 | ,, | ,, |
| ,, | 19 .. | 25 | 0 | 0 | ,, | ,, |
| ,, | 20 .. | 25 | 0 | 0 | ,, | ,, |
| ,, | 21 .. | 25 | 0 | 0 | ,, | ,, |

**Lead** (English).

| | | £ | s. | d. | | |
|---|---|---|---|---|---|---|
| June | 15 .. | 14 | 10 | 0 | No change | |
| ,, | 16 .. | 14 | 0 | 0 | dec. | 10/– |
| ,, | 19 .. | 14 | 5 | 0 | inc. | 5/– |
| ,, | 20 .. | 14 | 15 | 0 | ,, | 10/– |
| ,, | 21 .. | 14 | 15 | 0 | No change | |

### Imports and Exports of Iron and Steel Castings, etc., in May, 1933, compared with May, 1932 and 1931.

| | May, 1931. | May, 1932. | May, 1933. | May, 1931. | May, 1932. | May, 1933. |
|---|---|---|---|---|---|---|
| *Imports.* | Tons. | Tons. | Tons. | £ | £ | £ |
| Pipes and Fittings, Cast | 1,367 | 96 | 196 | 18,241 | 2,084 | 2,814 |
| Castings, in the Rough, Iron | 128 | 124 | 1 | 2,882 | 1,281 | 41 |
| ,, ,, ,, Steel | 587 | 112 | 56 | 11,237 | 1,767 | 985 |
| Hollow-ware, Cast, not Enamelled | 11 | 2 | 1 | 824 | 167 | 71 |
| ,, ,, Enamelled | 3 | 1 | 24 | 185 | 59 | 1,260 |
| *Exports.* | | | | | | |
| BUILDERS' CASTINGS— | | | | | | |
| To Argentine Republic | 34 | 55 | 6 | 1,260 | 1,396 | 347 |
| ,, Irish Free State | 325 | 341 | 354 | 15,318 | 16,137 | 14,954 |
| ,, British South Africa | 224 | 124 | 213 | 8,315 | 4,012 | 8,944 |
| ,, ,, India | 135 | 50 | 80 | 4,760 | 2,028 | 2,950 |
| ,, New Zealand | 26 | 33 | 26 | 1,452 | 1,331 | 1,477 |
| Total (including other countries) | 1,030 | 986 | 1,064 | 43,985 | 40,082 | 45,269 |
| PIPES AND FITTINGS—CAST— | | | | | | |
| To Argentine Republic | 370 | 135 | 50 | 3,524 | 1,482 | 546 |
| ,, Irish Free State | 1,827 | 842 | 624 | 19,247 | 12,095 | 7,436 |
| ,, British South Africa | 735 | 134 | 1,405 | 8,822 | 1,961 | 11,751 |
| ,, ,, India | 127 | 88 | 141 | 1,729 | 1,522 | 2,404 |
| ,, Straits Settlements and Malay States | 80 | 178 | 11 | 1,584 | 1,945 | 195 |
| Total (including other countries) | 7,426 | 6,007 | 7,149 | 85,704 | 61,619 | 67,512 |
| HOLLOW-WARE— | | | | | | |
| Cast, not Enamelled, and Cast, Tinned | 169 | 220 | 241 | 6,288 | 7,938 | 8,083 |
| ,, Enamelled | 30 | 103 | 37 | 3,458 | 8,264 | 3,711 |
| CASTINGS, IN THE ROUGH— | | | | | | |
| Iron | 215 | 79 | 98 | 4,446 | 3,167 | 3,356 |
| Steel | 24 | 70 | 99 | 1,149 | 3,193 | 3,595 |


WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

## SMALL ADVERTISEMENTS.

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ADVERTISER, last 6½ years with well-known iron merchants (export and home trade experience), and previously 4 years in accounts department of iron and steel manufacturer's office, desires post as Pig-iron Salesman or similar.—Box 444, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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